OPERATING INSTRUCTIONS

[redacted]

TYPE 1300-A

BEAT-FREQUENCY VIDEO GENERATOR

Serial No. 147

INSTRUMENT CENTER

SN 147

1300-A

GENERAL RADIO COMPANY

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OPERATING INSTRUCTIONS

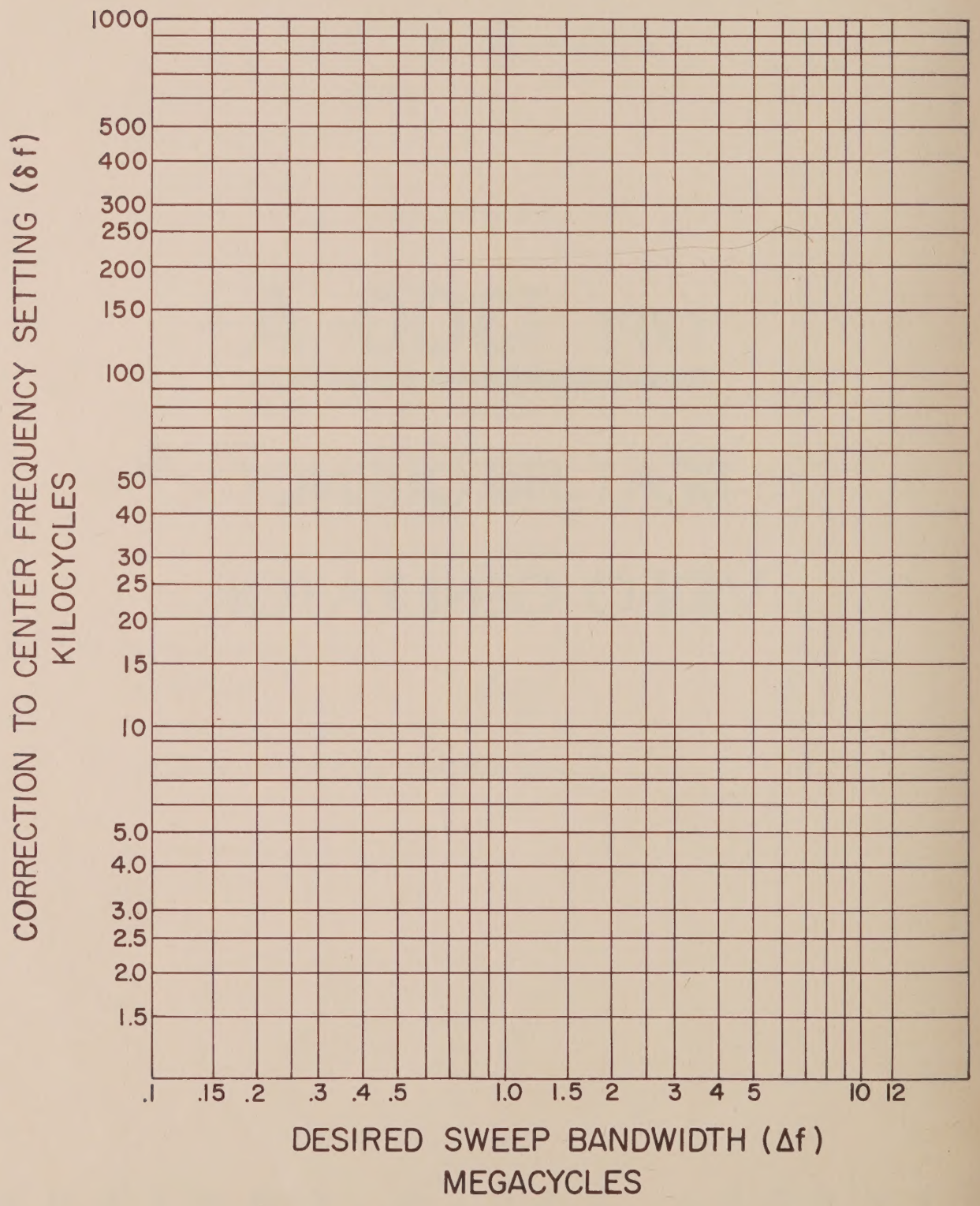
TYPE 1300-A

BEAT-FREQUENCY VIDEO GENERATOR

Form 3031-A
June, 1960

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS, USA

VIDEO SWEEP CALIBRATION CURVE FOR TYPE 1300-A, Serial No._____



SPECIFICATIONS

OUTPUT: *Frequency Range*	*Signal*	*Open-Cir. Amplitude*	*Tolerance*	*Impedance*
20-20,000 c	Sine Wave	0-10 v	<±0.25 db	820Ω ±2%
20-20,000 c	Sine Wave	0-1 v	<±0.25 db 40 c-20 kc 0 75 db at 20 c	75Ω ±2% Attenuator
20-20,000 c	Square Wave	0-10 v p-to-p (0-2.5 v p-to-p across 75Ω)	<±0.25 db	75Ω ±2% Attenuator
20 kc-12 Mc	Sine Wave	0-10 v	±1 db	820Ω ±2%
20 kc-12 Mc	Sine Wave	0-1 v	±1 db	75Ω ±2% Attenuator
20 kc-2 Mc	Square Wave	0-10 v p-to-p (0-2.5 v p-to-p across 75Ω)	±0.5 db	75Ω ±2% (Attenuator)
20 kc-12 Mc Center Freq. 0-±6 Mc Sweep	Sine-Wave Sweep*	0-10 v	±1 db (up to 12 Mc)	820Ω ±2%
20 kc-12 Mc Center Freq. 0-±6 Mc Sweep	Sine-Wave Sweep*	0-1 v	±1 db (up to 12 Mc)	75Ω ±2% (Attenuator)
30-42 Mc	Sine Wave	Approx. 50 mv	±1 db**	Approx. 50Ω
36-42 Mc Center Freq. 0-±6 Mc Sweep	Sine-Wave Sweep*	Approx. 100 mv	±2 db**	50Ω or higher load recommended

*Sweep rate is at power-line frequency.

**Typical, not guaranteed.

Frequency Controls: The main control has a dial with two scales.

The inner scale covers the audio range and is calibrated from 20 to 20,000 cycles per second with a true logarithmic distribution. The total scale length is approximately ten inches. The effective angle of rotation is 240° or 80° per decade of frequency.

The outer scale covers the video range and is calibrated from 20 kilocycles per second to 12 megacycles per second. The scale is approximately logarithmic but approaches a linear distribution at the high-frequency end. The total scale length is approximately 12 inches.

The frequency-increment dial for the audio range is calibrated from −50 to +50 cycles per second, and the frequency-increment dial for the video range is calibrated from −20 to +20 kilocycles per second.

Frequency Calibration Accuracy:

Audio Range: The calibration of the main frequency dial can be relied upon within ±(1% + 1 cycle) after the oscillator has been correctly set to zero beat. The accuracy of calibration of the frequency-increment dial is ±1 cycle.

Video Range and Video-Sweep Range: The calibration of the main frequency dial can be relied upon within ±(1% + 1 kc) from 500 kc to 12 Mc and within ±(2% + 1 kc) below 500 kc after the oscillator has been correctly set to zero beat. The accuracy of calibration of the frequency-increment dial is ±0.5 kc. The frequency-increment dial is not effective on the VIDEO-SWEEP RANGE.

Zero-Beat Indicator: The output voltmeter is used to indicate zero beat.

Frequency Stability:

Audio Range: The drift from a cold start is less than 20 cycles in two hours.

Video Range: The drift from a cold start is less than 20 kilocycles in two hours.

Output Voltmeter: The panel meter has two voltage scales, 0 to 10 and 0 to 3, and a db scale, −20 db to 0 db, referred to full deflection on the 0 to 10 scale. Calibration accuracy is within ±3% of full-scale deflection for sine waves, ±5% for square waves. The voltage scales are calibrated to indicate the r-m-s value of sine-wave output voltage and the peak-to-peak value of square-wave output voltage. The sine-wave voltmeter is connected in series with a 10-μf capacitor to the 10-volt output jack.

Output Attenuator: The 75-ohm attenuator has eight steps of 10 db each, with an accuracy of ±1% of the nominal attenuation. Maximum output from the attenuator is one volt for sine-wave output, 10 volts peak-to-peak for square-wave output. Sine-wave, full-scale, open-circuit voltages are 0.1 mv, 0.3 mv, 1 mv, 3 mv, 10 mv, 30 mv, 0.1 v, 0.3 v, and 1 v. Square-wave, full-scale, open-circuit voltages are 1 mv, 3 mv, 10 mv, 30 mv, 100 mv, 300 mv, 1 v, 3 v, and 10 v.

Horizontal Deflection Voltage: 4 volts at 60 cycles (or power-line frequency) are provided for horizontal deflection of a cathode-ray oscilloscope. Since both this voltage and the frequency distribution of the sweep output vary sinusoidally, the oscilloscope pattern is approximately linear. A blanking voltage (50-volt, peak-to-peak, square wave) is also supplied.

Square-Wave Characteristics: At 60 cycles the tops are flat within 2% of the peak-to-peak amplitude, at 20 cycles within 5%. Rise time for frequencies from 300 kc to 2 Mc is less than 75 millimicroseconds. At 20 kc the rise time is approximately 150 millimicroseconds. Overshoot is about 10% of the peak-to-peak output voltage.

Harmonic Distortion: The total harmonic distortion of the sine-wave output is less than 1% of output on the 20 c-20 kc range and less than 4% of output on the VIDEO SWEEP and 20 kc-12 Mc ranges.

A-C Hum: Less than 0.1% of the output for voltmeter readings above 10% of full scale.

Terminals: TYPE 874 Coaxial Terminals are provided for all outputs.

Mounting: Aluminum, 19-inch, relay-rack panel; aluminum cabinet. For table mounting (TYPE 1300-AM), aluminum end frames are supplied to fit ends of cabinet; for relay-rack mounting (TYPE 1300-AR), brackets for holding cabinet in rack are supplied. Relay-rack mounting is so arranged that panel and chassis can be removed from cabinet, leaving cabinet in rack, or cabinet can be removed from rear of rack, leaving panel attached to rack.

Power Supply: 105 to 125 (or 210 to 250) volts, 50 to 60 cycles. Power input at 117 volts is approximately 175 watts, maximum. Instrument will operate normally, except for sweep output, at supply frequencies up to 400 cycles.

Power input receptacle will accept either 2-wire (TYPE CAP-35) or 3-wire (TYPE CAP-15) power cord. Two-wire cord is supplied.

Tube Complement:

1 — OB2	1 — 6BA7
1 — 5651	1 — 6BC4
1 — 6080	1 — 6BK7-B
2 — 6197	1 — 6BQ5
4 — 6AB4	1 — 6J6
2 — 6AQ6	4 — 12AX7
1 — 6AV6	

Accessories Supplied: One TYPE CAP-35 Power Cord; two TYPE 874-R22 50-ohm Patch Cords; one TYPE 874-413 75-ohm Patch Cord; three TYPE 874-C58 Cable Connectors, one TYPE 874-Q2 Adaptor, and spare fuses.

Other Accessories Available: TYPE 1521-A Graphic Level Recorder for automatic recording at audio frequencies; TYPE 1750-A Sweep Drive for slow-speed sweeping; TYPE 908-R Dial Drive for X-Y plots; TYPE 1213-D Unit Time/Frequency Calibrator for timing markers.

Dimensions: 19 (width) x 15¾ (height) x 14⅜ inches (depth) over-all.

Net Weight: 64 pounds.

U. S. Patent No. 2,548,457.

GENERAL RADIO EXPERIMENTER reference: Vol 34, No. 2, February, 1960.

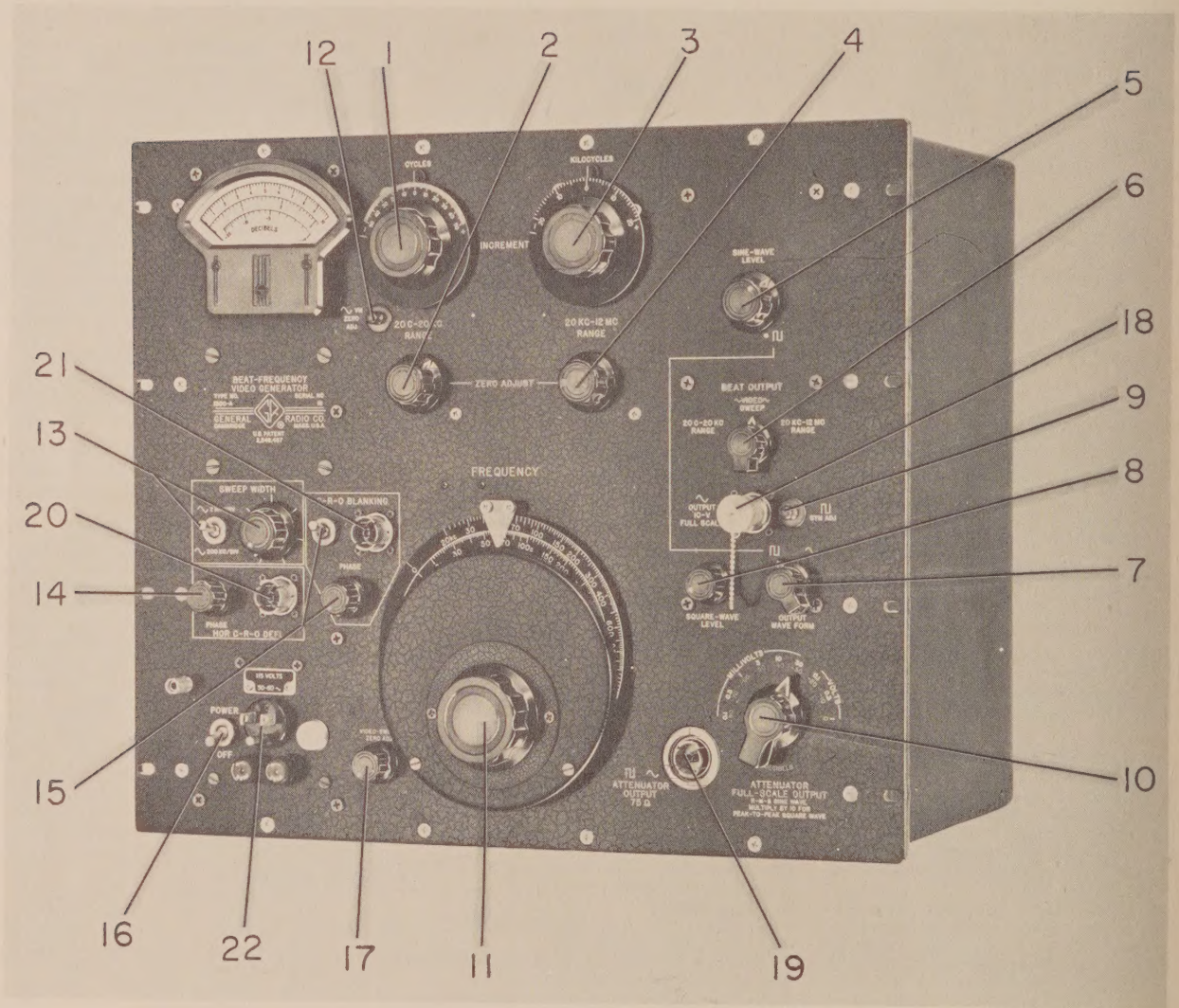


Figure 1. Type 1300-A Beat-Frequency Video Generator.
(Refer to paragraphs 1.2.2 and 1.2.3 for legend.)

TYPE 1300-A
BEAT-FREQUENCY VIDEO GENERATOR

Section 1
INTRODUCTION

1.1 PURPOSE. The Type 1300-A Beat-Frequency Video Generator (Figure 1) is a signal generator capable of supplying up to 10 volts across a high-impedance load and up to 1 volt behind 75 ohms at frequencies between 20 cycles and 12 megacycles. The output frequency may be swept at power-line frequency from 20 kc to 12 Mc, or over any part of this band. The Video Generator will supply a square-wave output of up to 2.5 volts peak-to-peak across 75 ohms at frequencies up to about 2 Mc. The Video Generator is very useful for rapid amplitude-vs-frequency testing of video-frequency equipment in both laboratory and production-line measurements.

1.2 DESCRIPTION.

1.2.1 GENERAL. The Video Generator is mounted in a heavy-gauge aluminum cabinet fitted with aluminum end frames for bench use. With the end frames removed, the instrument can be mounted in a 19-inch relay rack. Special rack-mounting brackets, supplied with the Type 1300-AR (Relay-Rack Model) Video Generator, attach cabinet and instrument to the relay rack and permit either to be withdrawn independently of the other. Instructions for installing the Type 1300-AR in a relay rack accompany these brackets.

1.2.2 CONTROLS. The following table lists controls on the Type 1300-A Beat-Frequency Video Generator:

TABLE OF CONTROLS

Name	Fig. 1 Ref.	Type	Function
CYCLES INCREMENT	1	Continuous rotary control with dial	Permits small frequency variations above and below the 20-cycle to 20-kc range.
ZERO ADJUST 20c-20kc RANGE	2	Continuous rotary control	Varies frequency for calibration of the 20-cycle to 20-kc range.
KILOCYCLES INCREMENT	3	Continuous rotary control with dial	Permits small frequency variation above and below the 20-kc to 12-Mc range.
ZERO ADJUST 20kc-12Mc RANGE	4	Continuous rotary control	Varies frequency for calibration of the 20-kc to 20-Mc range.
SINE-WAVE LEVEL	5	Continuous rotary control	Varies sine-wave output voltage from zero to maximum value for any attenuator setting.
BEAT OUTPUT	6	3-position rotary selector switch	Selects desired frequency range.
OUTPUT WAVE FORM	7	2-position rotary selector switch	Selects either sine-wave or square-wave output waveform.

(Continued)

TABLE OF CONTROLS (Cont.)

Name	Fig. 1 Ref.	Type	Function
SQUARE-WAVE LEVEL	8	Continuous rotary control	Varies square-wave output voltage from zero to maximum value for any attenuator setting.
SYM ADJ	9	Continuous rotary screw-driver adjustment	Adjusts symmetry of square-wave form.
ATTENUATOR	10	9-position rotary selector switch	Indicates full-scale output voltage and indicates attenuation in db.
FREQUENCY	11	Continuous rotary control with gear-driven calibrated dial	Together with INCREMENT and BEAT OUTPUT controls, indicates frequency of output signal.
∼ VM ZERO ADJ	12	Continuous rotary screw-driver adjustment	Adjusts voltmeter zero for sine-wave measurements.
SWEEP WIDTH	13	2-position toggle switch and continuous rotary control	Adjusts frequency deviation from 20 kc to 12 Mc, when BEAT OUTPUT switch is at VIDEO SWEEP.
HOR C-R-O-DEFL. PHASE	14	Continuous rotary control	Adjusts the phase of the signal supplied for horizontal deflection of an oscilloscope.
C-R-O BLANKING PHASE	15	2-position toggle switch and continuous rotary control	Adjusts phase of square-wave voltage supplied to blank undesired pattern on oscilloscope.
POWER	16	2-position toggle switch	Turns instrument on or off.
VIDEO-SWEEP ZERO ADJ	17	Continuous rotary control	Varies frequency of video-sweep output signal about 1-3/4 Mc.

1.2.3 CONNECTORS. The following table lists connectors on the Type 1300-A Generator:

TABLE OF CONNECTORS

Name	Fig. 1 Ref.	Type	Function
∼ OUTPUT 10-V FULL SCALE	18	Type 874 Coaxial Connector	Output terminal for sine-wave output up to 10-V.
⊓ ∼ ATTENUATOR OUTPUT 75 Ω	19	Type 874 Coaxial Connector	Attenuator output terminal for sine-wave signal up to 1v and for square-wave signal.
HOR C-R-O DEFL	20	Type 874 Coaxial Connector	Output terminal for signal for horizontal oscilloscope deflection to indicate video-sweep output.
C-R-O BLANKING	21	Type 874 Coaxial Connector	Output terminal for square-wave voltage to blank out undesired pattern on oscilloscope.

(Continued)

TABLE OF CONNECTORS (Cont.)

Name	Fig. 1 Ref.	Type	Function
(Internal)	J3 Fig. 7	Type 874 Coaxial Connector	Low-voltage output signal from high-frequency variable oscillator.
(Internal)	J101 Fig. 7	Type 874 Coaxial Connector	Low-voltage output signal from high-frequency swept oscillator.
POWER	22	Three-terminal male connector	Accepts power plug and cord supplied.

1.2.4 METER. The panel voltmeter is calibrated in terms of open-circuit voltage for both sine-wave and square-wave output signals. The full-scale output is the value indicated at the attenuator switch or at the ∼ OUTPUT 10-V FULL SCALE connector. The meter also has a decibels scale, with 0 db coinciding with full scale on the 0-10 scale. This scale may be used in conjunction with the decibels calibration of the attenuator switch to determine the output level in decibels referred to 1-volt open-circuit output. Full-scale open-circuit output at the ∼ OUTPUT 10-V FULL SCALE connector is +20 db referred to 1 volt.

1.3 ACCESSORIES. A power cord, three Type 874 Patch Cords (2 Type 874-R22; 1 Type 874-413), an adaptor to convert from Type 874 to Type 274 Connectors, three Type 874-C58 Connectors, and spare fuses are supplied with the instrument.

Section 2
PRINCIPLES OF OPERATION

2.1 GENERAL. (See elementary block diagram, Figure 2.) For audio-frequency sine-wave output, the low-frequency fixed oscillator (V3) delivers a signal at approximately 190 kc through a buffer (V2), to the mixer (V101), where the signal is combined with a signal variable in frequency from approximately 170 to 190 kc from the low-frequency variable oscillator (V6) and buffer (V5). The difference frequency, between 0 and 20 kc, is fed through a low-pass filter, which removes frequency components above 20 kc, to the amplifier (V201 through V204). The output from the amplifier is connected to the

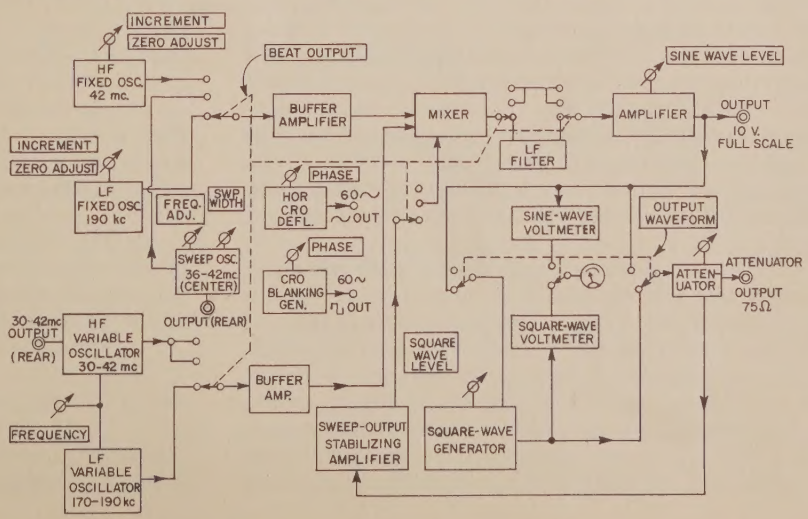


Figure 2. Elementary block diagram of Type 1300-A Beat-Frequency Video Generator.

sine-wave voltmeter (V305), to the high-output connector, and the attenuator.

For video-frequency sine-wave output, the input to the buffers (V2 and V5) is switched from the low-frequency oscillators to fixed and variable high-frequency oscillators (V1 and V4, respectively). The frequency of the high-frequency fixed oscillator is approximately 42 Mc, and the range of the high-frequency variable oscillator is from approximately 30 to 42 Mc. The low-pass filter between mixer and amplifier is switched out of the circuit.

For video-sweep sine-wave output, the sweep oscillator (V102) is switched into circuit in place of the high-frequency fixed oscillator (V1). The unswept frequency of the oscillator may be adjusted over a 6-Mc range by a control accessible from the rear of the instrument and approximately 1-3/4 Mc by the VIDEO-SWEEP ZERO ADJ control. The frequency can be swept electronically over a band up to 12 Mc wide with a power-line-frequency sine-wave distribution. During sweep operation, feedback from the output to a grid of the mixer tube maintains the output level vs frequency constant within ±1 db. In video-sweep operation, power-line-frequency sine-wave voltage is provided to be used as the horizontal deflection voltage of the cathode-ray oscilloscope used to observe the output of the equipment under test. The sine-wave deflecting voltage causes a trace on the tube in both directions (i.e., to left and to right), and a 50-volt peak-to-peak square wave is provided that can be used to blank out the undesired trace. The sine-wave deflecting voltage and the square-wave blanking voltage can each be adjusted in phase. Low-voltage outputs from the variable high-frequency oscillator and the sweep oscillator are accessible inside the instrument through holes in the back of the cabinet.

Square-wave output up to approximately 2 Mc is obtained at the attenuator output when the square-wave generator is switched to the amplifier output.

2.2 OSCILLATORS. There are five oscillators, used two at a time to obtain the various frequency ranges.

The two low-frequency oscillators and two high-frequency oscillators use high-quality components to insure frequency stability. The range switching is designed so that the same tuning capacitor is used for both the low- and the high-frequency variable oscillators. A minimum of switch and wiring capacitance is allowed to fall across the tuned circuits of the oscillators.

The sweep oscillator is paired with the high-frequency variable oscillator to supply mixer inputs for the video-sweep range. The tuned circuit is composed of a small inductor, a small variable capacitor, and the capacitances between the various elements of the oscillator tube. The division of tuned-circuit rf voltage from plate and grid to ground is determined by the grid-to-cathode, plate-to-cathode, and wiring capacitances. The tuned-circuit inductor is wound on a small, ferrite, toroidal core that is located between the pole pieces of an electromagnet and in the constant field of a permanent magnet. A sine-wave current passed through the electromagnet control winding causes a variation of magnetic flux in the ferrite core. Because of the steady flux bias provided by the permanent magnet, the flux varies from minimum to maximum with a sine-wave distribution. The permeability of the ferrite core varies with this flux and causes the frequency of the oscillator to vary at the power-line frequency with a nearly sine-wave distribution. The range of variation is determined by the amount of current passed through the control coil. The same frequency variation will occur at the output terminals of the Video Generator.

The signal from each operating oscillator is passed to the mixer through a buffer amplifier, to isolate the oscillators from each other.

2.3 MIXER. The 6BA7 mixer tube has separate bias adjustments on grids 1 and 3, for adjustment of the voltage and harmonic content of the output signal. When the video-sweep range is operating, feedback from the amplifier output is connected to the first grid in order to maintain a flat output-voltage-versus-frequency characteristic.

2.4 FILTER AND AMPLIFIER. On the 20-c to 20-kc range, the signal from the mixer is fed to the amplifier through a low-pass filter that cuts off above 20 kc. On the video-sweep and 20-kc to 12-Mc ranges no low-pass filter is used. The amplifier attenuates signals at oscillator frequency and higher.

Negative feedback is used in the five-stage amplifier to maintain a flat output characteristic from 20 cycles to 12 Mc and to minimize harmonic distortion. During square-wave output operation, the load resistance of the amplifier output tube is increased to provide a higher-voltage signal to operate the square-wave generator.

2.5 SQUARE-WAVE GENERATOR. The square-wave generator is a Schmitt circuit that is dc coupled to the attenuator. The positive peaks of the square wave are at ground level so the output contains a negative dc voltage component equal in magnitude to one-half the value of the peak-to-peak amplitude of the square-wave output. A separate level control is provided for adjusting the output from the square-wave generator.

2.6 OUTPUT SYSTEM. The output system consists of two level controls, one for sine-wave output and one for square-wave output, a 75-ohm step attenuator, and a panel voltmeter.

The SINE-WAVE LEVEL, in the input section of the amplifier, is used to control the sine-wave output, available at two connectors on the panel.

Up to 10 volts open-circuit is obtained at the ∼ OUTPUT 10-V FULL SCALE connector. The panel voltmeter indicates the voltage behind a capacitance

of 10 μf in series with the connector, so that at all except low audio frequencies the voltmeter indicates the actual voltage at the connector. At low audio frequencies, the voltage across a load at the connector depends upon the load and upon the reactance of the 10-μf capacitor. A shield cap on this connector eliminates radiation from the connector.

At audio and low video frequencies, a resistive load causes the voltmeter indication to decrease by an amount determined by the load resistance and the source resistance of 820 ohms. At high video frequencies this decrease is less and is determined by the load resistance, source resistance, and the stray capacitance in parallel with the source resistance. However, in all cases (except at low audio frequencies as explained above) the panel voltmeter indicates the actual voltage across the load.

Up to 1 volt open-circuit is available at the ATTENUATOR OUTPUT connector. The attenuator has eight 10-db steps. Each step is calibrated in decibels and in voltage for full-scale deflection of the panel voltmeter. The calibration is in decibels attenuation below 1 volt and in rms voltage behind 75 ohms.

Square-wave output is obtained only at the ATTENUATOR OUTPUT connector. The open-circuit, full-scale, peak-to-peak voltage output is indicated by the engraving at the ATTENUATOR switch and is ten times the rms value of the sine-wave output calibration. The maximum, full-scale, square-wave output is 10 volts peak-to-peak behind 75 ohms at open circuit, and 5 volts peak-to-peak behind 75 ohms with a 75-ohm load.

The panel meter has three scales; 0 to 10, 0 to 3, and -20 to 0 decibels. The 0-to-10 scale only is used for reading sine-wave voltage output at the ∼ OUTPUT 10-V FULL SCALE connector. All scales are used for reading either sine-wave or square-wave output voltage at the ATTENUATOR OUTPUT connector. The correct scale to read is indicated by the switch engraving.

The sine-wave voltmeter circuit is peak reading, but the meter is calibrated in rms voltage. If the VIDEO SWEEP range is used and the frequency is swept through zero beat the voltmeter will indicate high because of the high peak voltages of transients that occur when the frequency passes through zero. To avoid this high indication, adjust the controls so that the frequency does not quite reach zero. Refer to paragraph 3.4.2.1 for a further discussion of the voltmeter indication of the VIDEO SWEEP output.

The square-wave voltmeter circuit measures the peak-to-peak amplitude of the square-wave output voltage, and the meter is calibrated in peak-to-peak values. Moderate variations in the symmetry of the square wave do not affect the accuracy of the voltmeter reading.

Section 3
OPERATING PROCEDURE

3.1 CONNECTION TO POWER SUPPLY. Connect the Video Generator to a source of power as indicated on the metal plate at the input socket, using the plug and cord provided. While instruments are normally supplied for 115-volt operation, the power transformer can be reconnected (see Figure 10) for 230-volt operation. When changing connections, be sure to reverse the metal plate so that it will read 230 volts, and also replace the 1.6-ampere line fuses with fuses rated at 0.8 ampere.

3.2 VOLTMETER ZERO. Before the power is turned on, check that the voltmeter pointer is at zero, and zero it with adjustment on the meter if necessary. After the instrument has been on for about 10 minutes, set the BEAT OUTPUT to 20 c - 20 kc RANGE and the OUTPUT WAVEFORM to ∼ . Turn the SINE-WAVE LEVEL control to its zero-output position. Zero the meter pointer by means of the ∼VM ZERO ADJ control, if necessary.

3.3 FREQUENCY CALIBRATION.

3.3.1 GENERAL. The frequency calibration can be standardized at zero by use of the panel meter as an indicator. Where maximum stability of calibration is desired, check the calibration occasionally during the operating period and readjust if necessary.

3.3.2 20 c - 20 kc RANGE. Set the main FREQUENCY dial and the CYCLES INCREMENT dial to zero. Rotate the SINE-WAVE LEVEL control to obtain near full-scale reading on the meter. By means of the CYCLES ZERO ADJUST control, adjust the frequency until the meter pointer stops fluctuating and drops to zero.

3.3.3 20 kc - 12 Mc RANGE. Set the main FREQUENCY dial and the KILOCYCLES INCREMENT dial to zero. Rotate the SINE-WAVE LEVEL control to obtain near full-scale reading on the meter. By means of the KILOCYCLES ZERO ADJUST control, adjust the frequency until the meter pointer stops fluctuating and drops to zero.

3.3.4 ∼ VIDEO-SWEEP RANGE. There is a knob zero-adjustment and a screw-driver zero-adjustment available for this range. The knob, labeled VIDEO-SWEEP ZERO ADJ, located near the lower left-hand edge of the main-dial cover, will vary the output frequency about 1-3/4 Mc. The screw-driver adjustment (C109), which will vary the frequency over a 6-Mc range, is in the swept-oscillator compartment and is accessible through the hole in the back of the cabinet near the lower right-hand corner. The KILOCYCLES INCREMENT control is not operative on the VIDEO-SWEEP range. The zero adjustments are used to set to zero beat as desired for the particular method used for adjustment and calibration of the sweep width. (Refer to paragraph 3.4.2.3 for a complete description of the two adjustment methods available.)

3.4 USE OF THE VIDEO GENERATOR.

3.4.1 20 c - 20 kc AND 20 kc - 12 Mc RANGES.

3.4.1.1 Sine-Wave Output. Set the BEAT OUTPUT switch to 20 c - 20 kc RANGE or 20 kc - 12 Mc RANGE. Set the OUTPUT WAVE FORM switch to ∼. Sine-wave output is obtained at the ∼ OUTPUT 10-V FULL SCALE and ATTENUATOR OUTPUT connectors. The source impedance at the ∼ OUTPUT 10-V FULL SCALE connector is 820 ohms resistive. The panel voltmeter indicates the voltage across the load. (Refer to paragraph 2.6 for a description of the voltmeter operation.) The source impedance at the ATTENUATOR OUTPUT connector is 75 ohms. The panel voltmeter indicates the voltage behind 75 ohms. After the frequency has been correctly standardized (paragraph 3.3.2 and 3.3.3), the output frequency is the sum of the reading of the appropriate scale on the FREQUENCY dial and the reading of the appropriate INCREMENT dial.

3.4.1.2 Square-Wave Output. Set the BEAT OUTPUT switch to 20 c - 20 kc RANGE or 20 kc - 12 Mc RANGE. Set the SINE-WAVE LEVEL control fully clockwise (marked .⊓⊔ on the panel). Set the OUTPUT WAVE FORM switch to ⊓⊔. The square-wave output is obtained at the ATTENUATOR OUTPUT connector as long as the frequency does not exceed approximately 3 Mc. The amplitude of the output can be varied with the SQUARE-WAVE LEVEL control. The panel voltmeter indicates the peak-to-peak square-wave output voltage behind 75 ohms. A screwdriver adjustment, ⊓⊔ SYM ADJ, just above the OUTPUT WAVE FORM switch, can be used to adjust the symmetry of the square wave if necessary. After the frequency has been correctly standardized (paragraphs 3.3.2 and 3.3.3), the output frequency is the sum of the reading of the appropriate scale on the FREQUENCY dial and the reading of the appropriate INCREMENT dial.

NOTE

During square-wave-output operation, sine-wave voltage ranging from approximately 45 volts rms at 20 cycles to 15 volts rms at 3 Mc appears at the ∼ OUTPUT 10-V FULL SCALE jack. No load should be applied to this connector during square-wave operation of the Video Generator.

The maximum square-wave output voltage, obtained with the ATTENUATOR switch at 0 db, is 2.5 volts peak-to-peak across a 75-ohm load, or nearly 13 volts peak-to-peak open circuit. At 13 volts, the panel voltmeter will read off scale, since 0 to 10 volts peak-to-peak is the highest voltmeter range. The panel voltmeter reads the peak-to-peak square-wave voltage behind 75 ohms on two scales, 0 to 3 and 0 to 10. The voltage is denoted by the meter pointer indication and by the engraving at the ATTENUATOR switch. The correct scale is also indicated by the ATTENUATOR switch engraving.

The meter reading is affected by a 75-ohm load on the output in the 0-, 10-, and 20-decibel ATTENUATOR switch positions, because of the way the square-wave voltage is developed in the output circuit. As the attenuation is varied, the meter reading should be held constant by use of the SQUARE-WAVE LEVEL control in order to obtain attenuation in accurate 10-db steps.

When the frequency is varied over a wide range, a symmetrical square-wave may become unsymmetrical, that is, the duration times of the positive and negative peaks may become unequal. If necessary, the symmetry can be restored by the use of ⊓⊔ SYM ADJ adjustment.

Above approximately 4 Mc, the square-wave generator becomes inoperative and no square-wave output is available.

3.4.2 ∼ VIDEO-SWEEP RANGE.

3.4.2.1 General. During video-sweep operation the voltmeter responds to the maximum voltage output during a complete sweep cycle. When the frequency is swept through zero beat, the voltmeter responds to the amplitude of the transient caused as the fre-

quency passes through zero. If the frequency does not pass through zero, the voltmeter indicates the maximum rms voltage during the complete sweep cycle. During sweep operation, the output level is held by avc action to approximately an average of the levels that would occur at various frequencies during the sweep cycle if there were no avc action. With a wide-bandwidth sweep, the output available is less than for a narrow-bandwidth sweep. Up to 10 volts open-circuit output is available with a bandwidth of 12 Mc. The avc action does not control output-level variations that occur as the FREQUENCY dial is rotated. These variations are approximately the same as those that occur on the 20 kc - 12 Mc RANGE down to about 100 kc. The output at 20 kc on the ∿ VIDEO SWEEP range drops 3 db more than does the 20-kc output on the 20 kc-12 Mc RANGE.

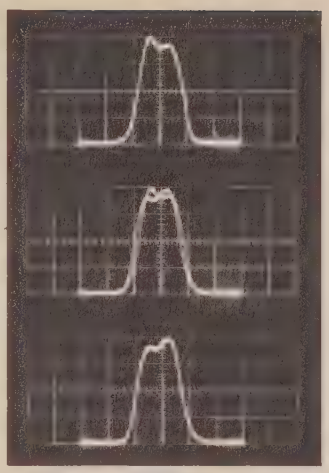
In some cases, when the sweep-frequency signal is used to test equipment having a low-frequency response, a small power-line-frequency component is generated that, together with the swept-frequency output, is applied to the oscilloscope vertical amplifier input. This component is of the same frequency as the horizontal deflection voltage and causes curvature of the pattern on the oscilloscope screen. A simple high-pass filter consisting of a series 1000-μμf capacitor followed by a shunt 68-kΩ resistor may be used before the oscilloscope to eliminate the power-line-frequency component.

The open-circuit ∿ VIDEO SWEEP output is flat within ±1 db when swept in frequency from 0 to 12 Mc and when the amplitude is near full scale on the voltmeter. At the 0-db switch position, a 75-ohm resistive load on the attenuator output causes the 12-Mc end of the swept output characteristic to droop about 1 db below the open-circuit characteristic. A load of 500 or more ohms may be used without degrading the response flatness appreciably. A 75-ohm load may be used at all other switch positions without affecting the flatness. VIDEO SWEEP output should generally be taken from the ATTENUATOR OUTPUT connector. If it is taken from the ∿10-V OUTPUT connector, the applied load will very likely degrade the response characteristic.

A Type 874-413 Patch Cord is supplied to connect equipment to the ATTENUATOR OUTPUT connector. At the 0-db switch position, this patch cord, when used without a termination, causes the swept output characteristic to rise at the 12-Mc end. A termination of approximately 150 ohms at the far end of the cord causes the characteristic to be flat out to 12 Mc. With a 75-ohm termination the cord has the same affect as a 75-ohm load. At all switch positions other than 0-db the patch cord, terminated or unterminated, has no effect on the output characteristic.

The SINE-WAVE LEVEL control should be set near maximum for the flattest swept-frequency output characteristic.

When an abruptly changing characteristic response is measured, the rate of change of frequency over the swept band may be great enough to cause distortion of the characteristic on the oscilloscope screen. (See Figure 3.) This condition can be detected as the C-R-O BLANKING switch is flipped from one position to the other to show the patterns for both increasing frequency and decreasing frequency. The two response patterns should be substantially identical if the sweep rate is not too great. The frequency scales of the two patterns differ, so there will be some differences in the horizontal dimensions, but the vertical amplitudes should be the same. (See Figure 3.)



(Top) Frequency swept from low to high value; *(bottom)* frequency swept from high to low value; *(center)* both traces superposed.

Figure 3. Plot of tuner i-f characteristic, showing distortion caused by excessive sweep rate. Frequency at the center line is 455 kc; scale, 10 kc/cm.

3.4.2.2 Detection Equipment. In practically all applications where the video-sweep range is used, a cathode-ray oscilloscope will be used to observe the output of the equipment being tested. If a wide-frequency-range oscilloscope is used, the video signal can be applied directly to the vertical-deflection amplifier input terminals. The pattern will show both positive and negative excursion of the video signal. The oscilloscope amplitude response should be flat to at least 12 Mc. A suitable detector can be used to rectify the video signal, and the resulting detector output at power-line frequency can be applied to the vertical-amplifier input of the oscilloscope. In this case, the oscilloscope amplitude response need be flat to only a few hundred cycles. The pattern shown on the oscilloscope screen will be, depending upon the detector design, the positive or negative envelope of the video signal into the detector.

3.4.2.3 Adjustment and Calibration. Set the BEAT OUTPUT switch to ∿ VIDEO SWEEP and the OUTPUT WAVEFORM switch to ∿ . Signal output to the instrument under test is obtained at the ATTENUATOR OUTPUT connector. Connect the HOR C-R-O DEFL output to the input terminals of the horizontal-

deflection amplifier of the oscilloscope. Connect the BLANKING output to the terminals provided for input of a signal to modulate the intensity of the electron beam.

NOTE

On many oscilloscopes, the time constant of the input circuit provided for introduction of a beam-intensity modulating signal is too short to pass the power-line-frequency, square-wave, blanking voltage. In such cases, one can sometimes locate a point in the oscilloscope circuit where the blanking voltage can be successfully introduced.

If the oscilloscope sweep circuit will operate with an external horizontal input applied, the Video Generator can be used to trigger the sweep with the oscilloscope's own blanking voltage used to blank the pattern. The desired sweep presentation can be obtained by variation of the blanking-voltage phase and the sweep duration. The sweep duration should be one half the period of the power-line frequency.

The duration time of positive and negative peaks of the oscilloscope square-wave, blanking voltage can be adjusted, if necessary, by means of the ⊓⊔ SYMMETRY C-R-O BLANKING adjustment located near the top of the left-hand instrument chassis. While observing the waveform on an oscilloscope rotate the adjustment until the widths of the positive and negative sections are equal (or unequal, if necessary for any particular reason).

Without the use of external calibration equipment, except a cathode-ray oscilloscope, either of two methods can be used to adjust and calibrate the sweep bandwidth.

METHOD 1. With this method the sweep bandwidth is adjusted so that the FREQUENCY dial indicates the actual center frequency of the band, and the low-frequency half of the band is calibrated in terms of the dial calibration.

a. Turn the SWEEP WIDTH control fully counterclockwise and set the FREQUENCY dial to zero.

b. Adjust to zero beat with the VIDEO-SWEEP ZERO ADJ control and, if necessary, with the screwdriver adjustment (C109) accessible through the back of the cabinet (use an insulated screw-driver).[1]

c. Set the HOR C-R-O DEFL PHASE control about 30° counterclockwise from midpoint.

d. Adjust the C-R-O BLANKING PHASE control so that a complete, one-direction pattern is shown on the oscilloscope screen.

e. From the calibration curve at the front of this manual obtain the center-frequency correction,[2] δf, for the desired bandwidth, Δf. Set the FREQUENCY dial to $\frac{\Delta f}{2} + \delta f$.

f. Adjust the SWEEP WIDTH control until the zero-beat indication appears near one end, which will be the low-frequency end, of the pattern on the oscilloscope screen. When the SWEEP WIDTH control setting is increased slightly, the zero-beat indication should split into two indications. If it does not split or does not appear, throw C-R-O BLANKING switch to the opposite position. The pattern should now show two zero-beat indications when the SWEEP WIDTH control is adjusted to obtain an indication at the end of the pattern. Adjust the SWEEP WIDTH control until the two indications merge.

g. By use of the HOR C-R-O DEFL PHASE, control, position the zero-beat indication at the end of the pattern.

h. Readjust the C-R-O BLANKING PHASE control, as before, so that one complete pattern is shown.

i. Reset the FREQUENCY dial to $\frac{\Delta f}{2}$.

j. With the VIDEO-SWEEP ZERO ADJ control, vary the sweep-oscillator frequency until the zero-beat indication is again at the end of the pattern.

k. Turn the FREQUENCY dial to zero.

l. Adjust the HOR C-R-O DEFL PHASE control until the zero-beat indication is in the center of the pattern.

m. If necessary, readjust the C-R-O BLANKING PHASE control so that one complete pattern is shown.

The sweep width is now adjusted to the desired value within ±5 percent, and the reading of the FREQUENCY dial is the actual center frequency of the band being swept. The oscilloscope pattern shows the frequency being swept from low to high values. The low-frequency half of the pattern can be calibrated in terms of the FREQUENCY dial calibration. With the dial set at $\frac{\Delta f}{2}$, the zero-beat indication is at zero frequency on the pattern. As the dial is rotated toward zero, the indication moves along the pattern by a frequency increment equal to the change in FREQUENCY dial setting until, with the dial at zero, the zero-beat indication is at a frequency of $\frac{\Delta f}{2}$, in the center of the pattern. Therefore, a frequency scale for the low-frequency half of the pattern can be marked on the oscilloscope screen. The upper half of the scale is approximately the mirror

[1] The quiescent frequency of the sweep oscillator depends on the previous magnetic history of the variable inductance unit in the oscillator circuit. Whenever the zero is being adjusted, it is advisable to rotate the continuous SWEEP WIDTH control back and forth, with the switch at 2 Mc/DIV, before setting it fully counterclockwise. This should also be done if the VIDEO-SWEEP ZERO ADJ control is rotated any considerable amount during the zero adjustment procedure. Set the SWEEP WIDTH control fully counterclockwise before throwing the switch from one position to the other, in order to minimize the the hysteresis effect.

[2] Because of hysteresis effects in the iron of the variable inductance unit, the frequency of the sweep oscillator does not swing equally to either side of the quiescent, or unswept, frequency. The amount by which the center frequency shifts from the quiescent value is plotted in the calibration curve at the front of this manual against the value of the desired bandwidth.

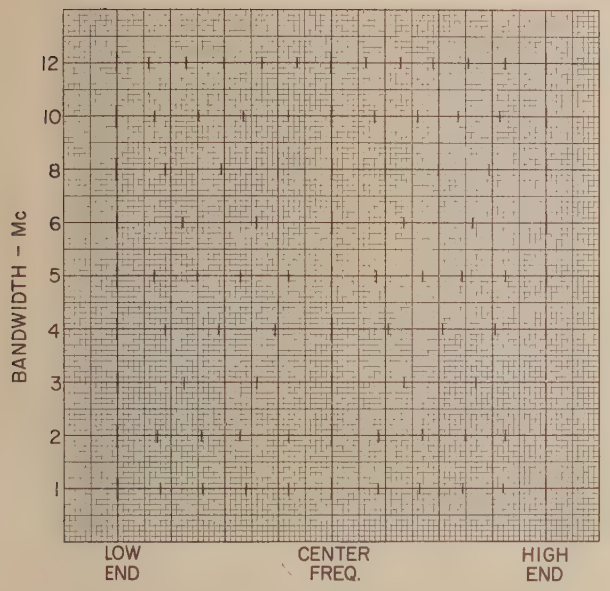


Figure 4. Frequency scales for various bandwidths, calibrated by Method 1, page 8.

image of the lower half. (See Figure 4 for representative scales.) The center frequency can be set at any frequency on the dial,[3] and the frequency calibration of the pattern in terms of Δf remains valid. The calibration is affected only by a change in the sweep-oscillator quiescent frequency or by a change in the bandwidth.

METHOD 2. The sweep bandwidth can be adjusted so that the entire pattern on the oscilloscope screen can be calibrated in terms of the FREQUENCY dial calibration. However, the dial will not indicate directly the actual center frequency, and the sweep-oscillator frequency adjustment, (C109) accessible through the back of the cabinet, must be used (except for bandwidths up to approximately 1 Mc, in which case the VIDEO-SWEEP ZERO ADJ control has sufficient adjustment range).

a. Turn the SWEEP WIDTH control fully counterclockwise.

b. From the calibration curve at the front of this manual obtain the center-frequency correction, δf, for the desired bandwidth, Δf.[2] Set the FREQUENCY dial to $\frac{\Delta f}{2} - \delta f$.

c. Adjust the frequency to zero beat with the VIDEO-SWEEP ZERO ADJ control and, if necessary, with the screw-driver adjustment (C109) accessible through the back of the cabinet[1] (use an insulated screw-driver).

d. Set the HOR C-R-O DEFL PHASE control about 30° counterclockwise from midpoint.

e. Adjust the C-R-O BLANKING PHASE control so that a complete, one-direction pattern is shown on the oscilloscope screen.

f. Set the FREQUENCY dial to Δf.

g. Adjust the SWEEP WIDTH control until the zero-beat indication appears near one end, which will be the low-frequency end, of the pattern on the oscilloscope screen. When the control setting is advanced, the zero-beat indications should split into two indications. If it does not split or does not appear, throw the C-R-O BLANKING switch to the opposite position. The pattern should now show two zero-beat indications when the control is adjusted to obtain an indication at the end of the pattern. Adjust the SWEEP WIDTH control until the two indications merge.

h. Reset the FREQUENCY dial to $\frac{\Delta f}{2}$.

i. Adjust the HOR C-R-O DEFL PHASE control until the zero-beat indication is in the center of the pattern.

j. Readjust the C-R-O BLANKING PHASE control, as before, so that one complete pattern is shown.

The sweep width is now adjusted to the desired value within ±5 percent. The oscilloscope pattern shows the frequency being swept from low to high values. The FREQUENCY dial indication is the high-frequency end of the band. The center frequency of the band is the dial reading minus $\frac{\Delta f}{2}$. The entire pattern can now be calibrated by use of the FREQUENCY dial calibration. With the dial set at Δf, the zero-beat indication is at zero frequency on the pattern. As the dial is rotated toward zero, the indication moves along the pattern by the same frequency increment indicated by the dial rotation until, with the dial at zero, the zero-beat indication is at the high-frequency end of the pattern. A frequency scale for the complete pattern can therefore be marked on the oscilloscope screen. The frequency scale, in terms of Δf, is not affected by any change in the FREQUENCY dial setting, but only by a change in the sweep-oscillator quiescent frequency or by a change in the bandwidth.

With either method of adjustment, the linearity of the frequency scale of the pattern over the desired bandwidth can be improved by adjustment of the actual bandwidth about 10 percent wider than desired.

Narrow sweep widths may be adjusted and calibrated by Method 2. The dial can then be set at zero and zero-beat set to the center of the pattern by use of VIDEO-SWEEP ZERO ADJ control. Dial indication is then the center frequency of the pattern.

3.4.2.4 Use of the Type 1213-D Unit Time/Frequency Calibrator. For more accurate calibration, an external generator, such as the General Radio Type 1213-D Unit Time/Frequency Calibrator, can be used. The procedure is as follows:

a. Connect the HOR C-R-O DEFL output to the input of the horizontal deflection amplifier of the

[3] If the dial is set below $\frac{\Delta f}{2}$, the frequency will sweep down through zero. If the setting plus $\frac{\Delta f}{2}$ is greater than 12 Mc, the amplitude-vs-frequency response of the Video Generator may deteriorate.

oscilloscope. Set the BEAT OUTPUT switch to ∼ VIDEO SWEEP and the OUTPUT WAVEFORM switch to ∼ . Connect the BLANKING output to the oscilloscope terminals provided for input of a signal to modulate the intensity of the electron beam. (Refer to NOTE, paragraph 3.4.2.3.)

b. Connect the RF INPUT connector of the Type 1213-D to the Video Generator ∼ OUTPUT 10-V FULL SCALE connector in series with a 5-μμf capacitor at the Video-Generator end of the connecting patch cord. The capacitor can be mounted in a Type 874-X Insertion Unit, which provides shielding as well as a convenient mechanical assembly.

c. Connect the Type 1213-D OUTPUT terminals to the vertical-amplifier terminals of the oscilloscope through a simple high-pass filter. A filter consisting of a series 1000-μμf capacitor followed by a shunt 68-kΩ resistor is satisfactory.

d. Set the Video Generator FREQUENCY dial to zero and the SWEEP WIDTH control fully counterclockwise. Adjust the frequency to zero beat with the VIDEO SWEEP ZERO ADJ control.

e. Turn the Type 1213-D OUTPUT switch to BEAT SIGNAL and the AUDIO GAIN control fully clockwise. Set the FUNDAMENTAL FREQUENCY switch to 1 Mc.

f. Adjust the Video Generator C-R-O BLANKING PHASE control for a complete one-direction pattern on the oscilloscope screen. Center the HOR C-R-O DEFL PHASE control.

g. Adjust the SWEEP WIDTH controls so that the frequency is swept several megacycles.

h. Adjust the oscilloscope vertical-amplifier gain and the Type 1213-D AUDIO GAIN to obtain a pattern similar to that shown in Figure 5. Reverse the position of the C-R-O BLANKING switch if necessary. The pattern in Figure 5 shows the frequency being swept from low to high values. To reverse the direction of sweep, throw the C-R-O BLANKING switch to the opposite position. With the frequency swept from high to low values, the blips on the pattern will be reversed.

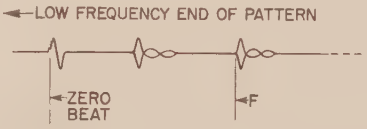


Figure 5. Oscilloscope pattern indicating shape of marker blips obtained from Type 1213-D.

Each blip in the pattern is caused by a damped oscillation, or "ringing", of the amplifier of the Type 1213-D as the input frequency is swept rapidly through a multiple of 1 Mc. The blip changes polarity rapidly in a random fashion. The zero-beat indication is as shown in Figure 5 and does not change polarity. Zero-beat occurs about at the point indicated. The point, F, on the frequency blip indicates very closely the point on the pattern where the frequency is a multiple of 1 Mc.

To use markers at 100-kc intervals, set the FUNDAMENTAL FREQUENCY switch of the Type 1213-D to 100 kc. A 1000- to 2000-μμf capacitor can be connected across the oscilloscope vertical-amplifier input terminal after the high-pass filter to attenuate the rf voltage applied to the oscilloscope. With narrow-sweep bandwidths the 100-kc marker blip resembles the usual beat-frequency pattern. The zero beat near the center of the blip indicates very closely the point on the pattern where the frequency is a multiple of 100 kc.

When the sweep has been adjusted to the required bandwidth, set the FREQUENCY dial to one-half the bandwidth. Adjust the VIDEO-SWEEP ZERO ADJ control until the zero-frequency mark is at the left end of the pattern. As the dial is rotated, it will indicate the center frequency of the band being swept. To obtain best linearity, adjust the HOR C-R-O DEFL PHASE control until the center frequency marker is in the center of the pattern on the oscilloscope screen.

By use of a dual-trace oscilloscope it is possible to show the pattern of the output from the instrument under test and the marker pattern simultaneously.

3.4.3 OSCILLATOR OUTPUT. Outputs from the high-frequency variable oscillator and the sweep oscillator are accessible through the back of the cabinet at Type 874 connectors. A connector on a flexible cable can be easily plugged into the sweep-oscillator connector, which is located on the left chassis close to the back of the cabinet (J101). Unless the cabinet is removed, a connector on a rigid line (such as a Type 874 Rigid Air Line) must be used for connection to the variable-oscillator connector J3, which is in about four inches from the back of the cabinet. The two oscillator outputs are not amplitude-controlled as the frequency is varied.

The frequency of the variable oscillator can be varied by use of the FREQUENCY dial from about 42 to 30 Mc. The frequency is highest with the dial set at zero and decreases according to the dial calibration as the reading is increased. The availability of the variable-oscillator output makes it possible to use the Video Generator for various types of tracking measurements. Combination of the variable-oscillator output and the beat output in an external mixing circuit results in an output signal whose frequency (that of the Video Generator fixed oscillator) remains constant as the FREQUENCY dial is rotated.

The quiescent frequency of the sweep oscillator can be set anywhere in the range from 36 to 42 Mc by the sweep-oscillator frequency adjustment accessible through the rear of the cabinet. The adjusted frequency can be swept up to plus and minus 6 Mc, for a total bandwidth of 12 Mc. The frequency of the swept band can be made to cover the television i-f band, so that it is possible to apply the Video Generator to the measurement of television i-f amplifier characteristics using sweep frequency techniques.

Section 4
SERVICE AND MAINTENANCE

4.1 GENERAL. The two-year warranty given with every General Radio instrument attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible.

In case of difficulties that cannot be eliminated by the use of these service instructions, please write or phone our Service Department, giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial and type numbers of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest district office (see back cover), requesting a Returned Material Tag. Use of this tag will insure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

4.2 ADJUSTMENTS.

NOTE

As you face the panel of the instrument the right-hand chassis is on the right; left-hand chassis, on the left.

4.2.1 TEST POINTS. Test points are provided inside the instrument on the right-hand chassis for general service and calibration purposes. Most of the test points are of the pin-jack type, which will accept the tip of the common test leads supplied with many voltmeters. The test points on the chassis from top to bottom, are:

TP201	DC HEATER SUPPLY	+19 V ±1 V
TP204	B+ SUPPLY	+270 V (Adjusted)
TP101	REG B+ SUPPLY	+162 V ±5 V
TP203	V203, V204 SUPPLY	+170 V ±10 V
TP301	⊓⊔ B SUPPLY	-300 ±30 V (With square-wave generator operating)
TP202	FEEDBACK	10 to 20 ohms (to ground)

Near the top of the right-hand chassis are two small, low-capacitance, test points, which are connected to the first and third grids of the mixer tube (V101).

TP102	V_{ff} (Fixed-frequency voltage)	(See par. 4.2.3.1 and 4.2.3.2)
TP103	V_{fv} (Variable-frequency voltage)	(See par. 4.2.3.1 and 4.2.3.2)

All dc voltages are to ground, and should be measured with an accurate voltmeter having an input resistance of 10 kilohms per volt or higher. The rf voltages at TP102 and TP103, should be measured with a low-capacitance-input vacuum-tube voltmeter such as the General Radio Type 1800-B.

4.2.2 ADJUSTMENT OF B+ SUPPLY VOLTAGE. This voltage can be measured at TP204 and adjusted to 270 volts by use of R508 (B+ ADJUST), located toward the rear of the left-hand chassis.

4.2.3 ADJUSTMENT OF RF INPUT TO MIXER.

4.2.3.1 Adjustment of RF Input from Low-Frequency Fixed and Variable Oscillators. Set the BEAT OUTPUT switch to 20 c to 20 kc RANGE, and the FREQUENCY dial to 1 kc. With C14, adjust the voltage at TP102 to 2 ±0.1 volts. With C34, adjust the voltage at TP103 to 1 ±0.05 volts. C14 and C34 are located under the shield cover of S101 (see Figure 8). If it is necessary to change the setting of either C14 or C34, it may be necessary to readjust the oscillator frequencies to obtain zero beat. The zero-beat adjustment must be made after each rf input adjustment in order to preserve the accuracy of the FREQUENCY dial calibration. For example, after varying C14, set the CYCLES INCREMENT and FREQUENCY dials to zero. Adjust for zero beat with the CYCLES ZERO ADJUST control. If it is impossible to adjust for zero beat, or, if zero beat is obtained with the ZERO ADJUST control considerably off center position, center the control and adjust for zero beat with C20, labeled FREQ ADJ L-F FIXED OSC, located toward the rear of the left-hand chassis. After adjusting C34, follow the same procedure, using C39 (FREQ ADJ L-F VAR OSC), located directly under C20.

4.2.3.2 Adjustment of RF Input from High-Frequency Fixed and Variable Oscillators. Set the BEAT OUTPUT switch to 20 kc- 12 Mc RANGE, and the FREQUENCY dial to 1 Mc. With C8 adjust the voltage at TP102 to 2 ±0.1 volts. This voltage value is for the unloaded condition. The vacuum-tube voltmeter probe should be connected to the test point with very short leads or with no leads at all, if possible. The voltmeter load on the circuit affects the voltage at the test point, and the beat-frequency output voltage as indicated on the panel meter is affected proportionally. Therefore, the change in the panel-meter indication can be used to correct the vacuum-tube voltmeter indication to the unloaded condition.

With C32 adjust the voltage at TP103 to obtain the same beat-frequency output voltage as on the 20 c - 20 kc RANGE. C8 is accessible through the back of the high-frequency fixed-oscillator compartment and is labeled OUTPUT ADJ. C32 is located under the shield cover of S101 (see Figure 8).

Adjustment of either C8 or C32 may make it necessary to readjust the oscillator frequencies to obtain zero beat. As explained in paragraph 4.2.3.1 frequency adjustment should be made after each rf input adjustment. After varying C8, adjust to zero beat, if necessary, with C3, (FREQ ADJ), located on the rear of the high-frequency fixed oscillator compartment. After varying C32, adjust to zero beat, if necessary, with C30, (FREQ ADJ), located on the rear of the high-frequency variable oscillator compartment.

4.2.3.3 Adjustment of RF Input from Sweep Oscillator. Set the BEAT OUTPUT switch to ∿VIDEO SWEEP and the SWEEP WIDTH control to minimum. Set the FREQUENCY dial to zero. Adjust to zero beat. Adjust the SWEEP WIDTH control for 12 Mc bandwidth. (Refer to paragraph 3.4.2.3 METHOD 1). With C110 adjust for the same output voltage as obtained on the 20 c - 20 kc RANGE. (The frequency must not be sweeping through zero beat.) C110 is accessible through the back of the sweep-oscillator compartment and is labeled OUTPUT ADJ.

4.2.4 ADJUSTMENT OF MIXER DISTORTION AND OUTPUT. A General Radio Type 736-A Wave Analyzer or the equivalent is required for this adjustment. Set the BEAT OUTPUT switch to 20 c-20 kc RANGE and the frequency to 1 kc. Connect the Type 736-A Wave Analyzer, with the input impedance set at 1 megohm, to the grid of the first section of V201. Adjust R103 to minimize the second harmonic of 1 kc. Tune the wave analyzer to the 1 kc fundamental and adjust R104 for a 1 kc output of 110 millivolts. If necessary, readjust R103 and R104 until the desired output is obtained with minimum second harmonic.

R103 and R104 are located near the center of the right-hand chassis.

4.2.5 CALIBRATION OF PANEL VOLTMETER.

4.2.5.1 General. Separate calibrating adjustments are provided for sine-wave and square-wave voltage measurement. Before starting either calibration procedure, check and, if necessary, adjust the meter mechanical zero.

4.2.5.2 Sine-Wave Voltage Calibration. Set the switch and controls for 1-kc sine-wave output. Check the electrical zero of the meter and adjust it if necessary. Connect an accurate vacuum-tube voltmeter to the ∿ 10-V OUTPUT connector and adjust the output voltage to a convenient value near full scale on the 0-10 scale of the panel meter. With R325, adjust the reading of the panel meter to agree with the reading of the standard voltmeter. R325 (∿ VM CAL) is located near the top of the left-hand chassis.

4.2.5.3 Square-Wave Voltage Calibration. Set the switches and controls for 1-kc square-wave output. Connect either an accurate peak-to-peak-reading vacuum-tube voltmeter or a calibrated cathode-ray oscilloscope to the ATTENUATOR OUTPUT connector. The load on the attenuator output should be at least 50 kilohms. Set the attenuator switch to the 0-db position. Adjust the output voltage to a convenient value near full scale on the 0-10 scale of the panel meter. With R327, adjust the reading of the panel meter to agree with the peak-to-peak output as measured by the standardizing instrument. R327 (⊓⊔ VM CAL) is located above V303 on the right-hand chassis.

4.2.6 ADJUSTMENT OF SWEEP WIDTH. The maximum sweep width varies with power-line voltage and can be adjusted by means of R429. Set the controls for video-sweep output and for maximum sweep width. Adjust R429 for a sweep width of 12-13 Mc. (Refer to paragraph 3.4.2.3 for sweep-width calibration procedure.) R429 is located on the terminal strip in the left-hand chassis (see Figure 6).

4.2.7 ADJUSTMENT OF ZERO-ADJUST RANGE.

4.2.7.1 General. If the zero-beat drifts out of the range of the ZERO ADJUST control, the correct range can be restored by a slight adjustment of an oscillator trimmer capacitor.

4.2.7.2 20 c-20 kc Range. Set the FREQUENCY dial and CYCLES INCREMENT dial to zero. Center the ZERO ADJUST control. Adjust either C20 (FREQ ADJ L-F FIXED OSC) or C39 (FREQ ADJ L-F VAR OSC) for zero-beat. C20 and C39 are located towards the back of the left-hand chassis.

4.2.7.3 20 kc-12 Mc Range. Set the FREQUENCY dial and KILOCYCLES INCREMENT dial to zero. Center the ZERO ADJUST control. Adjust either C3 (H-F FIXED OSC FREQ ADJ) or C30 (H-F VAR OSC FREQ ADJ) for zero beat. C3 is accessible at the rear of the high-frequency fixed-oscillator compartment. C30 is accessible at the rear of the high-frequency variable-oscillator compartment.

TABLE OF VOLTAGES

Tube (Type)	Pin	DC Volts to Gnd. (A)	Res. to Gnd. (B)	Remarks
V1 (6AB4)	1 (P)	+152	1.2 k	20 kc-12 Mc Range
	3-4 (H)	±6.3 ac		
	6 (G)	-5	2.7 k	20 kc-12 Mc Range
	7 (C)	0	0	
V2 (6AB4)	1 (P)	+250	1.2 k	
	3-4 (H)	±6.3 ac		
	6 (G)	+57	118 k	
	7 (C)	+60	5.7 k	
V3 (6AQ6)	1 (G)	-8	1.8 M	20 c-20 kc Range
	2 (C)	0	0	
	3-4 (H)	±6.3 ac		
	7 (P)	+155	15 k	20 c-20 kc Range
V4 (6AB4)	1(P)	+150	1.2 k	20 kc-12 Mc Range
	3-4 (H)	±6.3 ac		
	6 (G)	-4	2.7 k	20 kc-12 Mc Range
	7 (C)	0	0	
V5 (6AB4)	1 (P)	+250	1.2 k	
	3-4 (H)	±6.3 ac		
	6 (G)	+47	118 k	
	7 (C)	+50	5.7 k	
V6 (6AQ6)	1 (G)	-8	1.8 M	20 c-20 kc Range
	2 (C)	0	0	
	3-4 (H)	±6.3 ac		
	7 (P)	+155	15 k	20 c-20 kc Range
V101 (6BA7)	1 ($G_{2,4}$)	+115	18 k	
	2 (G_1)	0	150 k	197 k on VIDEO SWEEP
	3 (C)	7.5	5 k	
	5 (H)	6		
	6 (G_5)	0	0	
	7 (G_3)	3	150 k	
	9 (P)	+265	11 k	
V102 (6J6)	1,2 (P)	+140	1.2 k	VIDEO SWEEP Range
	3-4 (H)	±6.3 ac		
	5,6 (G)	-4	10 k	VIDEO SWEEP Range
	7 (C)	0	0	
V201 (12AT7)	1 (P_1)	+240	5.1 k	
	2 (G_1)	0	1 M	35 kilohms on VIDEO SWEEP
	3 (C_1)	1.5	180	
	4,5 (H)	+6.0		
	6 (P_2)	+182	8.2 k	
	7 (G_2)	0	1 M	
	8 (C_2)	+1	100	
	9 (H)	+12.2		
V202 (6BC4)	1,9 (P)	+110	33 k	
	2,3,7,8 (G)	0	500	SINE WAVE LEVEL at max. 14 k on 20 c-20 kc range
	4 (H)	+12.2		
	5 (H)	+18.3		
	6 (C)	+1.4	300	
V203 (6BK7B)	1,6 (P)	+160	3.8 k	
	2,7 (G)	0	470 k	
	3,8 (C)	+1.3	62	
	4-5 (H)	±6.3 ac		
V204 (6BQ5)	2 (G)	+0.6	470 k	These figures apply to SINE WAVE output
	3 (C)	+2.75	75	
	4-5 (H)	±6.3 ac		
	7 (P)	+140	865	
	9 (S)	+150	24 k	

Tube (Type)	Pin	DC Volts to Gnd. (A)	Res. to Gnd. (B)	Remarks
V301 (6AB6)	1 (G)	0	1 M	VIDEO SWEEP range only
	2 (C)	+1.4	1.5 k	
	3-4 (H)	±6.3 ac		
	7 (P)	+175	100 k	
V303 (6197)	1,7 (C)	-200	1.5 k	Square Wave Output only
	4-5 (H)	±6.3 ac		
	6 (P)	-54	1.5 k	Square Wave Output only
	8 (S)	-86	82 k	Square Wave Output only
	9 (G)	-200	≈100 k	Depends on setting of SYM ADJ (R307)
V304 (6197)	1,7 (C)	-200	1.5 k	Square Wave Output only
	4-5 (H)	±6.3 ac		
	6 (P)	-10	420	Max Square Wave level only
	8 (S)	-37	8.2 k	Max Square Wave level only
	9 (G)	-240	6.3 k	Max Square Wave level only
V305 (12AX7)	1,2 (P_1)	+38	22 M	Sine Wave only.
	3 (C_1)	+39	20 k	SINE WAVE LEVEL set CCW
	4,5-9 (H)	±6.3 ac		
	6 (P_2)	+270	0	Sine Wave only
	7 (G_2)	+38	44 M	SINE WAVE LEVEL
	8 (C_2)	+40	47 k	set CCW
V401 (OB2)	1,5 (P)	+270		
	2,4,7 (C)	+162		
V402 (12AX7)	1 (P_1)	+210	90 k	
	2 (G_1)	+70	160 k	
	3 (C_1)	+84	120 k	
	4,5-9 (H)	±6.3 ac		
	6 (P_2)	+240	82 k	
	7 (G_2)	+66	245 k	
	8 (C_2)	+84	120 k	
V501 (6080)	1,4 (G)	+233		
	2,5 (P)	+370		
	3,6 (C)	+270	0	
	7-8 (H)	±6.3 ac		Heater is +270 V above ground
V502 (12AX7)	1 (P_1)	+233		
	2 (G_1)	+157		
	3 (C_1)	+163	470 k	
	4,5-9 (H)	±6.3 ac		Heater is +120 V above ground
	6 (P_2)	+163	470 k	
	7 (G_2)	+81	500 k	
	8 (C_2)	+82	56 k	
V503 (5651)	1,5 (P)	+82	56 k	
	2,4,7 (C)	0	0	

NOTES:

(A) Voltages are measured with a meter that has a much higher impedance than that of the voltage being measured (as listed under "Res. to Gnd.").
(B) Resistance is measured with power OFF, and with TP101, TP204, and TP301 connected to chassis.

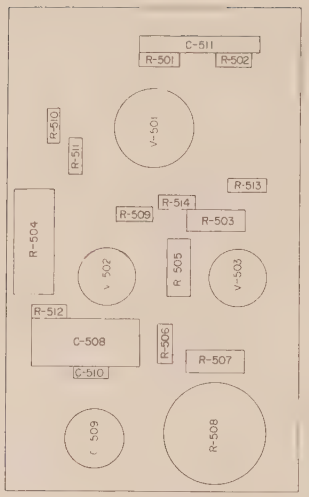
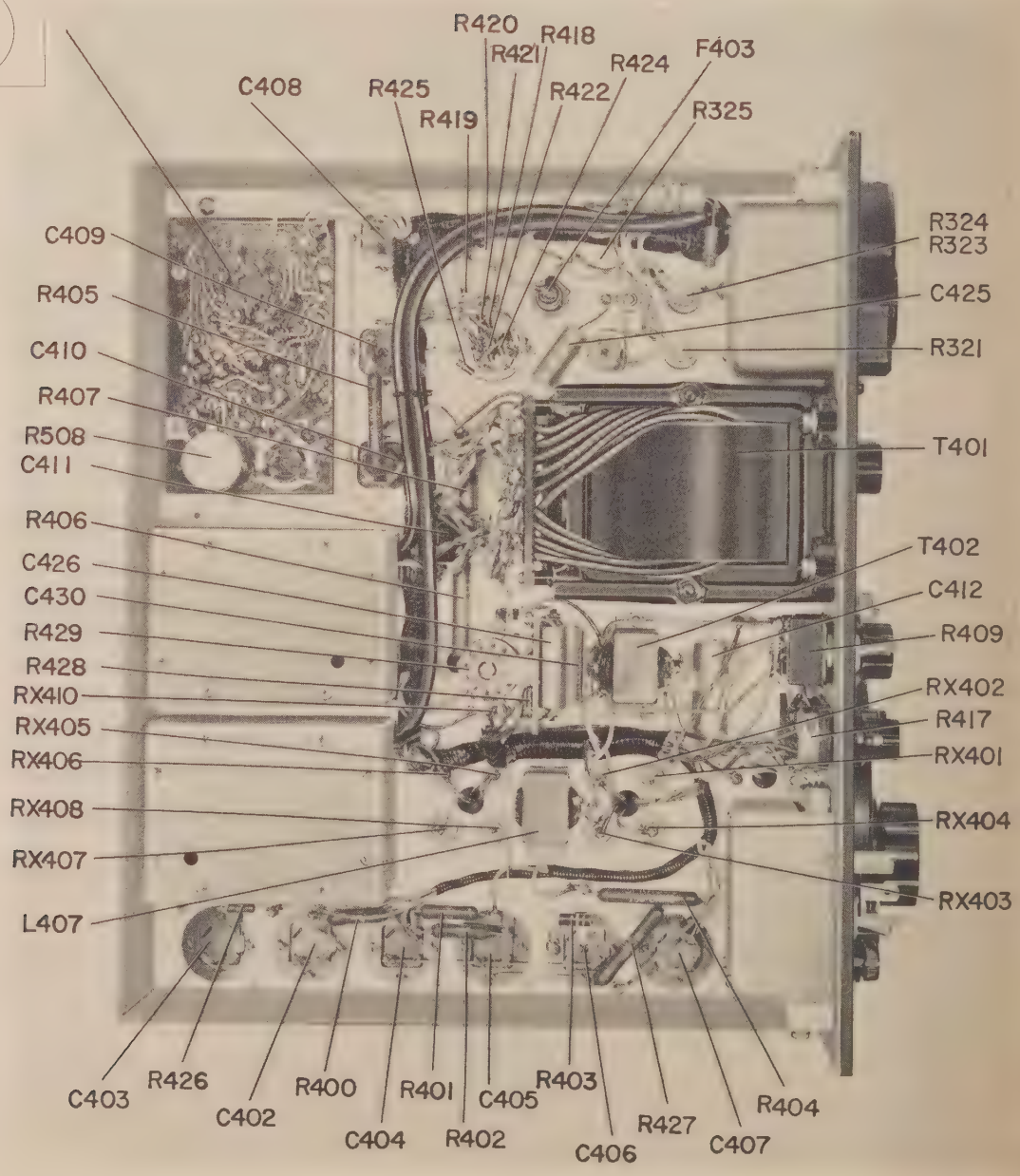


Figure 6. Left Interior View.



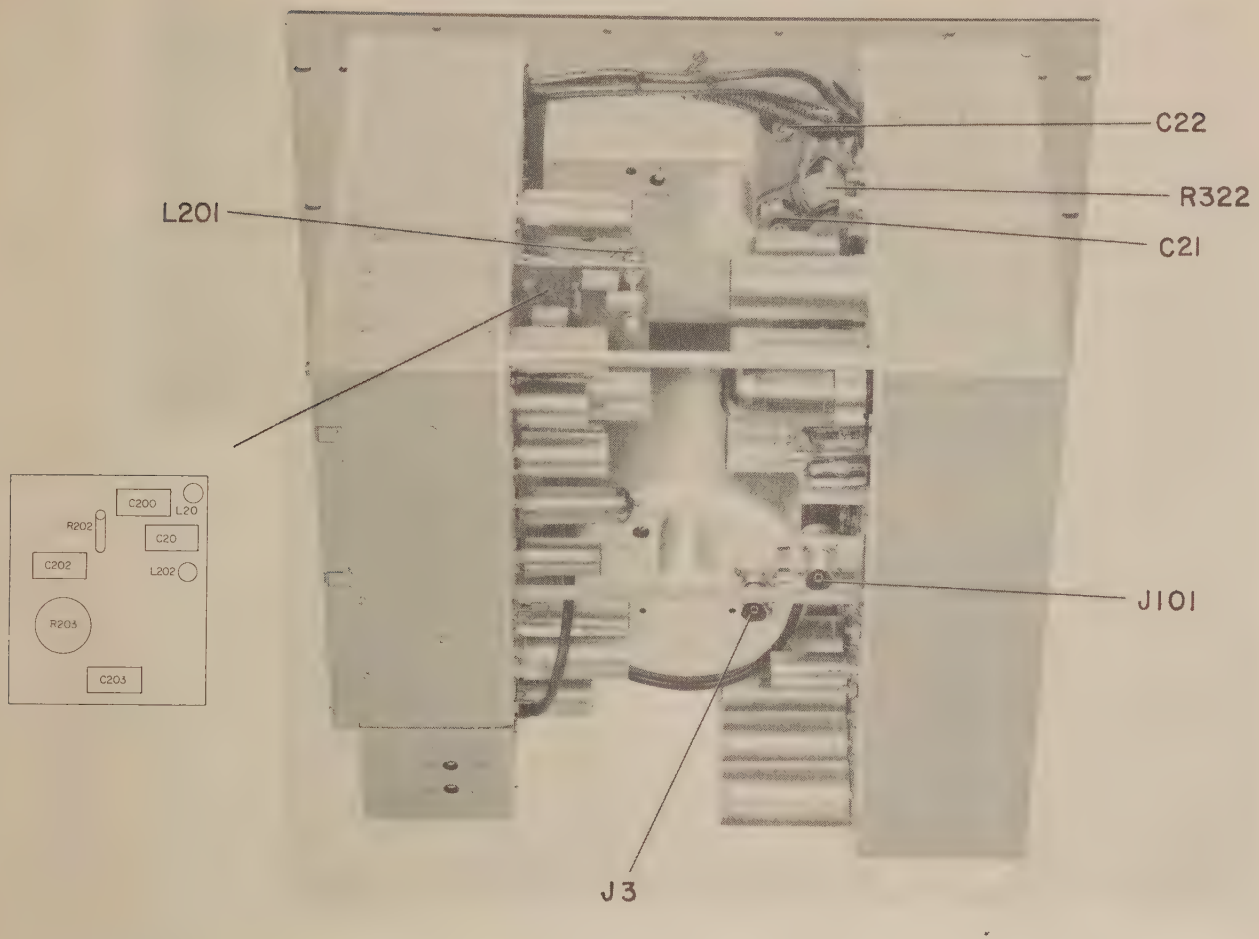


Figure 7. Rear Interior View.

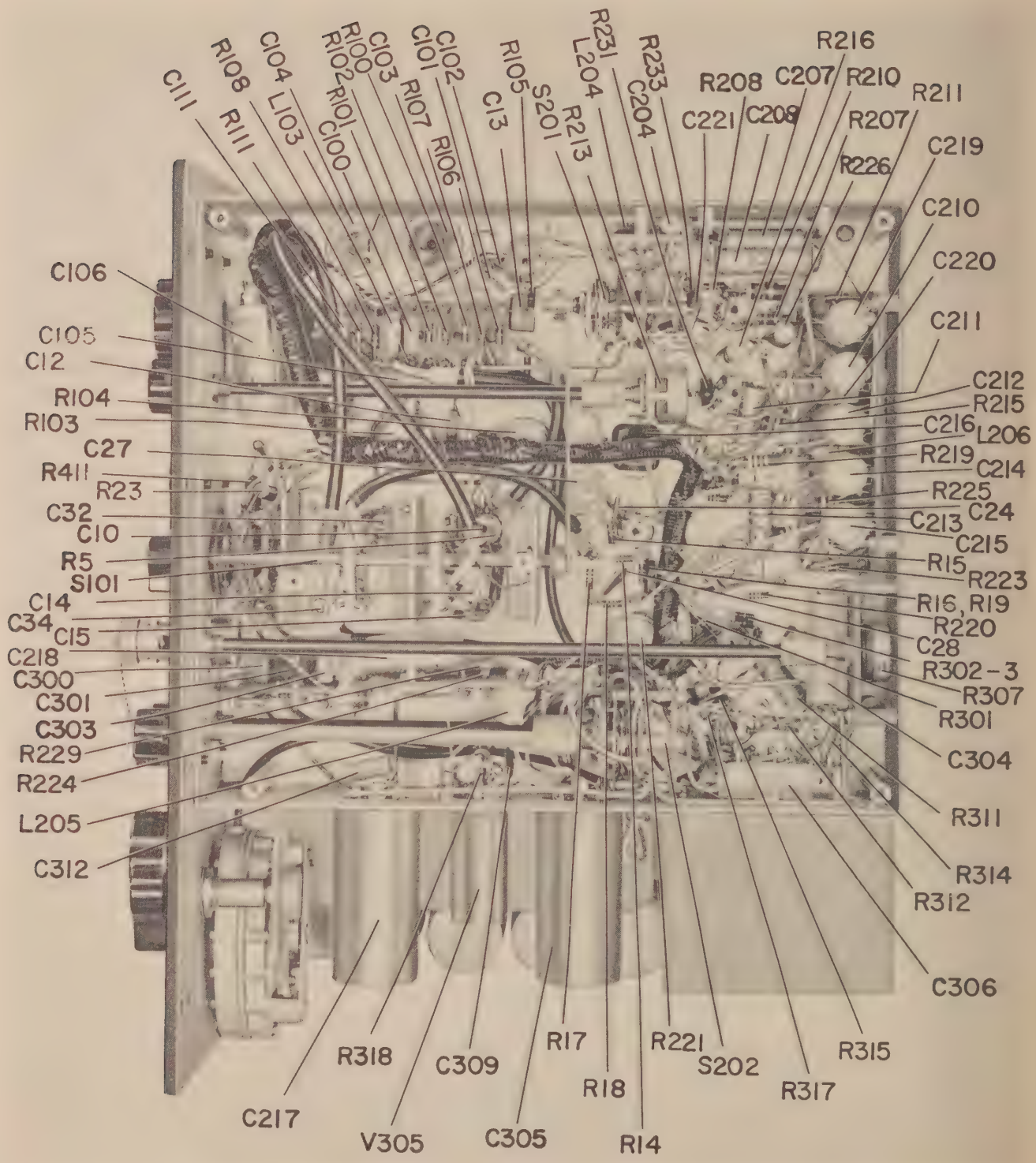


Figure 8. Right Interior View.

PARTS LIST

RESISTORS. All resistances are in ohms, except k = kilohms, M = megohms

	PART NO. (NOTE A)				PART NO. (NOTE A)				PART NO. (NOTE A)			
R1	2.7 k	±5%	1/2 w	REC-20BF	R219	430	±5%	1 w	REC-30BF	R408	33 k	±5%	1/2 w	REC-20BF
R2	1	±10%	1/2 w	REW-3C	R220	470 k	±5%	1/2 w	REC-20BF	R409	5 k	±5%		971-M
R3	1.2 k	±5%	1/2 w	REC-20BF	R221	50	±10%		POSC-11	R411	15 k	±5%	10 w	REPO-44
R4	1.2 k	±5%	1/2 w	REC-20BF	R222	62	±5%	1/2 w	REC-20BF	R412	250 k	±10%		POSC-25
R5	470	±5%	1/2 w	REC-20BF	R223	47	±5%	1/2 w	REC-20BF	R413	160 k	±1%	1/2 w	REPR-17
R6	150	±5%	1/2 w	REC-20BF	R224	2 k	±5%	1/2 w	REC-20BF	R414	6.8	±10%	1/2 w	REW-3C
R7	56 k	±5%	1/2 w	REC-20BF	R225	24 k	±10%	2 w	REC-41BF	R415	50 k	±10%		POSC-12
R8	56 k	±5%	1/2 w	REC-20BF	R226	3.3 k	±5%	10 w	REPO-22					
R9	5.6 k	±5%	1 w	REC-20BF	R227	375	±1%	1 w	REF-75	R417	50 k	±10%		POSC-12
R10	22	±5%	1/2 w	REC-20BF	R228	375	±1%	1 w	REF-75	R418	680 k	±5%	1/2 w	REC-20BF
R11	1.8 M	±5%	1/2 w	REC-20BF	R229	114	±1%	1/2 w	REF-70	R419	150 k	±5%	1/2 w	REC-20BF
R12	15 k	±5%	1/2 w	REC-20BF	R230	47 k	±5%	1/2 w	REC-20BF	R420	250 k	±10%		POSC-11
R13	2.7 k	±5%	1/2 w	REC-20BF	R231	82	±5%	1 w	REC-30BF	R421	100 k	±5%	1/2 w	REC-20BF
R14	470	±5%	1/2 w	REC-20BF	R232	6.8 k	±5%	1/2 w	REC-20BF	R422	680 k	±5%	1/2 w	REC-20BF
R15	1.2 k	±5%	1/2 w	REC-20BF	R233	6.8 k	±5%	1/2 w	REC-20BF	R423	120 k	±5%	1/2 w	REC-20BF
R16	150	±5%	1/2 w	REC-20BF	R234	56	±5%	1/2 w	REC-20BF	R424	82 k	±5%	1/2 w	REC-20BF
R17	56 k	±5%	1/2 w	REC-20BF	R235	100 k	±5%	1/2 w	REC-20BF	R425	360 k	±5%	1/2 w	REC-20BF
R18	56 k	±5%	1/2 w	REC-20BF						R426	5	±5%	3 w	REPO-45
R19	5.6 k	±5%	1 w	REC-30BF						R427	10	±5%	10 w	REPO-44
R20	51	±5%	1/2 w	REC-20BF	R300	100 k	±5%	1/2 w	REC-20BF	R428	4.7 k	±5%	1/2 w	REC-20BF
R21	15 k	±5%	1/2 w	REC-20BF	R301	100 k	±5%	1/2 w	REC-20BF	R429	10 k	±10%		POSC-11
R22	1.8 M	±5%	1/2 w	REC-20BF	R302	1.5 k	±5%	1/2 w	REC-20BF	R430	51 k	±5%	1/2 w	REC-20BF
R23	10 k	±5%	10 w	REPO-44	R303	1 M	±5%	1/2 w	REC-20BF	R431	1 k	±5%	1/2 w	REC-20BF
R24	1.2 k	±5%	1/2 w	REC-20BF	R304	120 k	±5%	1/2 w	REC-20BF	R432	1 k	±5%	1/2 w	REC-20BF
					R305					R433	1 k	±5%	1/2 w	REC-20BF
					R306	51 k	±5%	1/2 w	REC-20BF	R434	1 k	±5%	1/2 w	REC-20BF
R100	150 k	±5%	1/2 w	REC-20BF	R307	250 k	±10%		POSC-7					
R101	150 k	±5%	1/2 w	REC-20BF	R308									
R102	47 k	±5%	1/2 w	REC-20BF	R309					R501	1 M	±5%	1/2 w	REC-20BF
R103	10 k	±10%		POSC-11	R310	8.2 k	±5%	2 w	REC-41BF	R502	2.4 M	±5%	1/2 w	REC-20BF
R104	10 k	±10%		POSC-11	R311	1.5 k	±5%	5 w	REPO-42	R503	36 k	±1%	1/4 w	REF-65
R105	56	±5%	1/2 w	REC-20BF	R312	220 k	±1%	1/2 w	REF-70	R504	30 k	±1%	1 w	REF-75
R106	56	±5%	1/2 w	REC-20BF	R313	3 k	±5%	5 w	REPO-42	R505	36 k	±1%	1/4 w	REF-65
R107	18 k	±5%	1/2 w	REC-20BF	R314	91 k	±1%	1/4 w	REF-65	R506	470 k	±5%	1/2 w	REC-20BF
R108	1 k	±5%	1/2 w	REC-20BF	R315	8.2 k	±5%	2 w	REC-41BF	R507	39 k	±1%	1/4 w	REF-65
R109	1.2 k	±10%	1 w	REC-30BF	R316	10 k	±10%		POSC-12	R508	10 k	±10%		POSW-3
R110	10 k	±5%	1/2 w	REC-20BF	R317	98.7	±1%	1/2 w	REF-70	R509	5.6 M	±5%	1/2 w	REC-20BF
R111	20 k	±5%	1/2 w	REC-20BF	R318	22 M	±5%	1/2 w	REC-20BF	R510	100	±5%	1/2 w	REC-20BF
					R319	22 M	±5%	1/2 w	REC-20BF	R511	100	±5%	1/2 w	REC-20BF
					R320	100 k	±5%	1/2 w	REC-20BF	R512	470 k	±5%	1/2 w	REC-20BF
R200	1 k	±5%	1/2 w	REC-20BF	R321	150 k	±1%	1/2 w	REPR-17	R513	620 k	±5%	1/2 w	REC-20BF
R201	10 k	±5%	1/2 w	REC-20BF	R322	2.5 k	±10%		POSC-3	R514	120 k	±5%	1/2 w	REC-20BF
R202	6.8 k	±5%	1/2 w	REC-20BF	R323	25 k	±1%	1/3 w	REPR-16					
R203	10 k	±10%		POSC-11	R324	20 k	±1%	1/3 w	REPR-16	R604	213.5	±0.5%		825-401
R204	6.8 k	±5%	1/2 w	REC-20BF	R325	10 k	±10%		POSC-3	R605	144.4	±0.5%		825-401
R205	1 M	±5%	1/2 w	REC-20BF	R326	10 k	±1%	1/8 w	REF-60	R606	213.5	±0.5%		825-401
R206	36 k	±5%	1/2 w	REC-20BF	R327	50 k	±10%		POSC-11	R607	144.4	±0.5%		825-401
R207	5.1 k	±5%	1 w	REC-30BF	R328	18 k	±1%	0.3 w	REPR-22	R608	213.5	±0.5%		825-401
R208	1 M	±5%	1/2 w	REC-20BF	R329	18 k	±1%	0.3 w	REPR-22	R609	144.4	±0.5%		825-401
R209	100	±5%	1/2 w	REC-20BF	R330	3 k	±5%	5 w	REPO-42	R610	213.5	±0.5%		825-401
R210	8.2 k	±5%	2 w	REC-41BF						R611	144.4	±0.5%		825-401
R211	270	±5%	1/2 w	REC-20BF	R400	330	±5%	5 w	REPO-43	R612	213.5	±0.5%		825-401
R212	180	±5%	1/2 w	REC-20BF	R401	330	±5%	5 w	REPO-43	R613	144.4	±0.5%		825-401
R213	500	±10%		POSC-7	R402	330	±5%	5 w	REPO-43	R614	213.5	±0.5%		825-401
R214	300	±5%	1/2 w	REC-20BF	R403	180 k	±5%	1 w	REC-30BF	R615	144.4	±0.5%		825-401
R215	33 k	±10%	1 w	REC-30BF	R404	150	±5%	10 w	REPO-44	R616	213.5	±0.5%		825-401
R216	2.7 k	±5%	10 w	REPO-22	R405	150	±5%	10 w	REPO-44	R617	144.4	±0.5%		825-401
R217	470 k	±5%	1/2 w	REC-20BF	R406	2.2	±5%	2 w	REW-6C	R618	213.5	±0.5%		825-401
R218	62	±5%	1/2 w	REC-20BF	R407	2.2	±5%	2 w	REW-6C	R619	98.7	±0.5%		825-401

Refer to page 19 for Note A.

(Continued)

PARTS LIST (Cont)

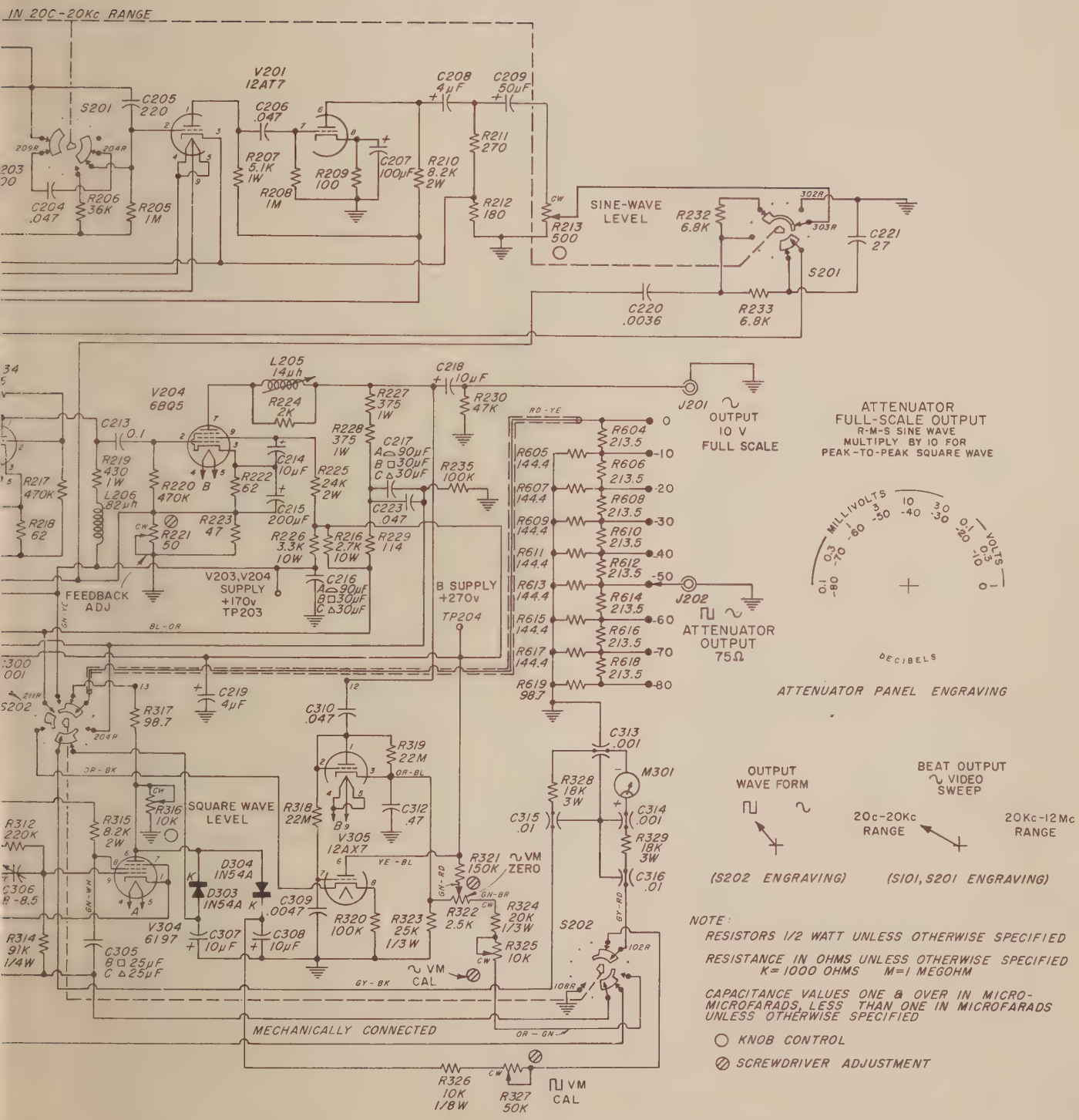
CAPACITORS. Capacitances are in μf unless otherwise indicated.

	PART NO. (NOTE A)			
C1	100 μμf	±10%	500 dcwv	COM-5B
C2	22 μμf	±10%	N750	COC-21
C3	6-100 μμf			COA-4
C4				846-405-2
C5	2.6 μμf			846-406
C6	0.002	+30-10%		COU-28
C7	0.001	±10%	500 dcwv	COM-20B
C8	1.5-7 μμf			COT-17
C9	22 μμf	±10%	500 dcwv	COM-20B
C10	0.01		500 dcwv	COC-62
C11	0.01		500 dcwv	COC-62
C12	100 μμf	±10%	500 dcwv	COM-20B
C13	470 μμf	±10%	500 dcwv	COM-20B
C14	0.8-8.5 μμf			COT-27
C15	47 μμf	±10%	500 dcwv	COM-20B
C16	160 μμf	±10%	500 dcwv	COM-20B
C17	0.5	±10%	600 dcwv	COL-72
C18	0.01		500 dcwv	COC-62
C19	330 μμf	±2%	500 dcwv	COM-20E
C20	6-100 μμf			COA-4L
C21	2.6 μμf			846-402-2
C22				846-405
C23	0.002	+30-10%	400 dcwv	COU-28
C24	0.01		500 dcwv	COC-62
C25	100 μμf	±10%	500 dcwv	COM-20B
C26	0.001	±10%	300 dcwv	COM-20B
C27	5-20 μμf			COT-18
C28	0.01		500 dcwv	COC-62
C29	340 μμf	±2%	500 dcwv	1300-41
C30	6-100 μμf			COA-4L
C31				539-417
C32	0.8-8.5 μμf			COT-27
C33	15 μμf	±10%	N750	COC-21
C34	0.8-8.5 μμf			COT-27
C35	150 μμf	±10%	500 dcwv	COM-20B
C36	160 μμf	±10%	500 dcwv	COM-20B
C37	0.5	±10%	600 dcwv	COL-72
C38	0.01		500 dcwv	COC-62
C39	100 μμf			COA-4
C40	10 μμf	±0.5 μμf	500 dcwv	COM-20E
C41	15 μμf	±0.5 μμf	500 dcwv	COM-20E
C42	0.8-8.5 μμf			COT-27
C43	10 μμf	±2%	500 dcwv	COM-20E
C44	15 μμf	±2%	500 dcwv	COM-20E
C45	0.8-8.5 μμf			COT-27
C46	7-45 μμf			COT-12
C100	470 μμf	±10%	500 dcwv	COM-20B
C101	0.01		500 dcwv	COC-62
C102	0.01		500 dcwv	COC-62
C103	50		200 dcwv	COE-51
C104	600		15 dcwv	COE-36
C105	0.1	±10%	400 dcwv	COW-25
C106	30		350 dcwv	COE-53
C107	0.002	+30-10%	400 dcwv	COU-28
C108	0.001	±10%	300 dcwv	COM-20B
C109	2.7-19.6 μμf			COA-29-4
C110	1.7-8.7 μμf			COA-29-2
C111	0.01	±10%	400 dcwv	COW-25
C112	0.47 μμf	±10%	500 dcwv	COC-1

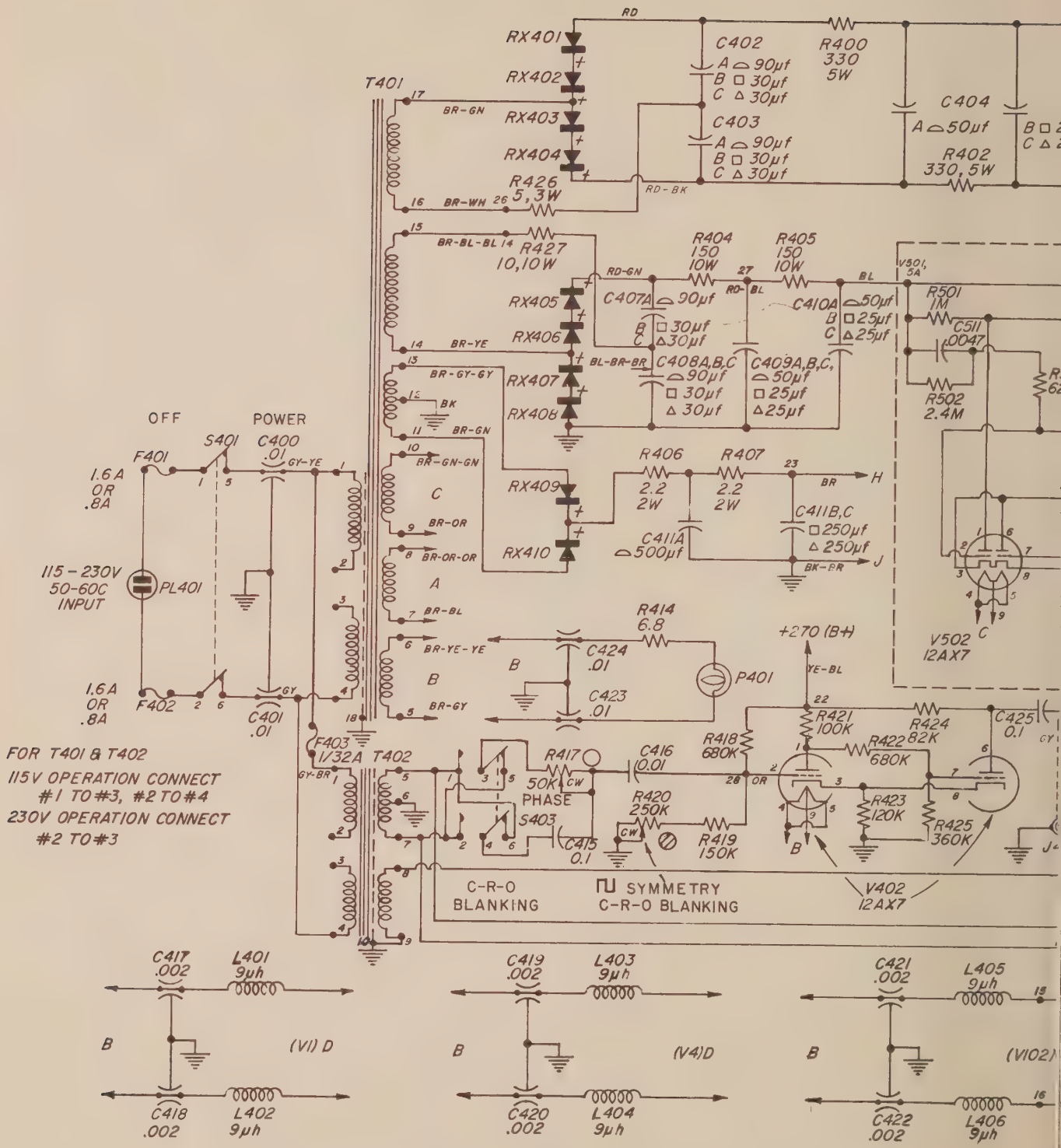
	PART NO. (NOTE A)			
C113	0.002	+30-10%	400 dcwv	COU-28
C114	0.002	+30-10%	400 dcwv	COU-28
C200	0.0015	±2%	500 dcwv	COM-5E
C201	910 μμf	±2%	500 dcwv	COM-5E
C202	0.0036	±2%	500 dcwv	COM-5E
C203	100 μμf	±2%	500 dcwv	COM-5E
C204	0.047	±10%	400 dcwv	COW-25
C205	220 μμf	±10%	500 dcwv	COM-20B
C206	0.047	±10%	400 dcwv	COW-25
C207	100		3 dcwv	COE-46
C208	4		450 dcwv	COE-32
C209	50		15 dcwv	COE-47
C210	200		10 dcwv	COE-6
C211	0.1	±10%	400 dcwv	COW-25
C212	200		10 dcwv	COE-6
C213	0.1	±10%	400 dcwv	COW-25
C214	10		250 dcwv	COE-33
C215	200		10 dcwv	COE-6
C216A	90			
C216B	30		300 dcwv	COE-52
C216C	30			
C217A	90			
C217B	30		300 dcwv	COE-52
C217C	30			
C218	10		250 dcwv	COE-33
C219	4		450 dcwv	COE-32
C220	0.0036	±2%	500 dcwv	COM-5E
C221	27 μμf	±10%	500 dcwv	COM-20B
C222	4		450 dcwv	COE-32
C223	0.047	±10%	400 dcwv	COW-25
C300	0.001	±10%	500 dcwv	COM-5B
C301	0.022		500 dcwv	COC-62
C302				
C303	0.0022	±10%	500 dcwv	COM-5B
C304	0.47	±10%	600 dcwv	COP-19
C305A	50			
C305B	25		450 dcwv	COE-10
C305C	25			
C306	0.8-8.5 μμf			COT-27
C307	10		50 dcwv	COE-49
C308	10		50 dcwv	COE-49
C309	0.0047		500 dcwv	COC-62
C310	0.047		400 dcwv	COW-25
C312	0.47	±10%	100 dcwv	COW-17
C313	0.001	±20%	500 dcwv	COC-3
C314	0.001	±20%	500 dcwv	COC-3
C315	0.01	+20-10%	400 dcwv	COU-16
C316	0.01	+20-10%	400 dcwv	COU-16
C400	0.01	+20-10%	400 dcwv	COU-16
C401	0.01	+20-10%	400 dcwv	COU-16
C402A	90			
C402B	30		300 dcwv	COE-52
C402C	30			
C403A	90			
C403B	30		300 dcwv	COE-52
C403C	30			

Refer to page 19 for Note A.

(Continued)

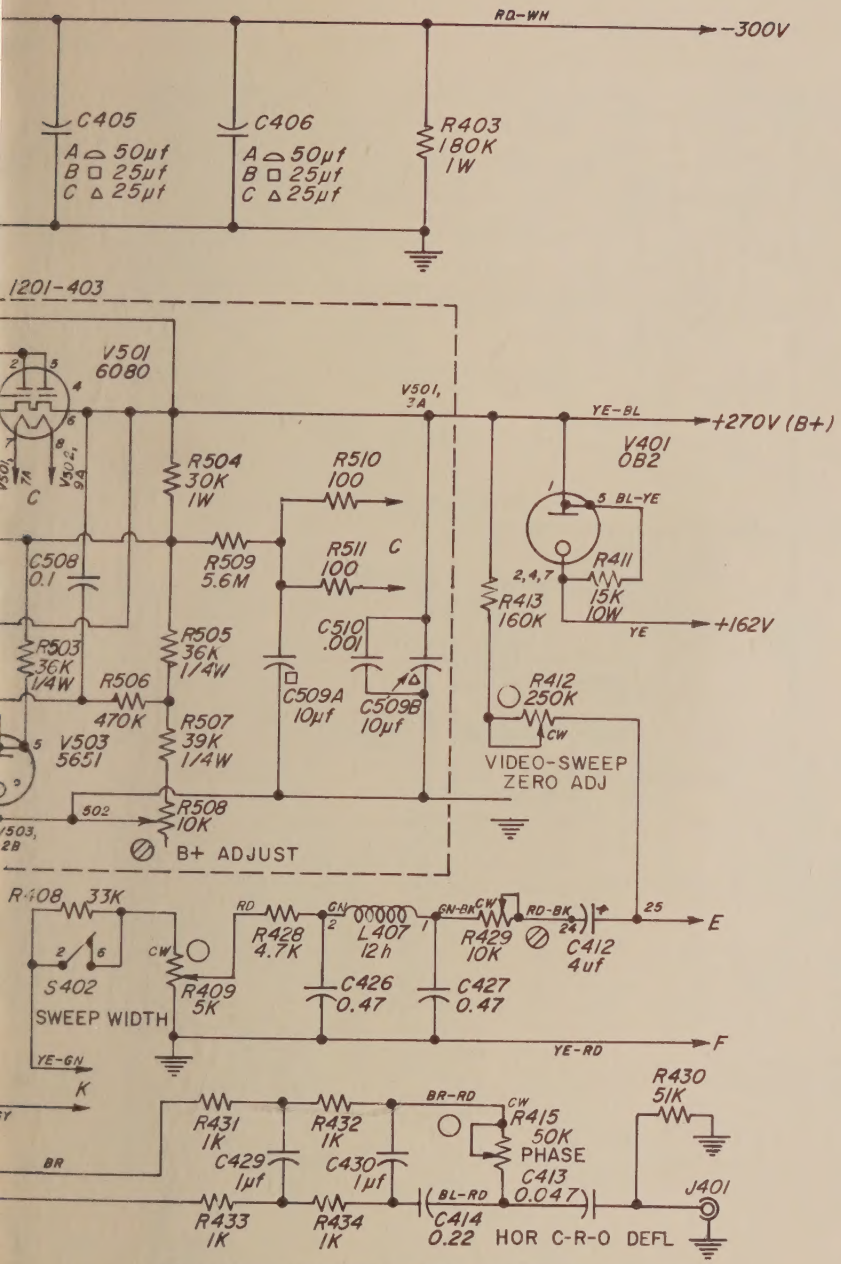


)-A Beat-Frequency Video Generator.



HIGH FREQUENCY OSCILLATOR HEATER FILTERS (ONE FILTER TO EACH FILTER "D")

Figure 10. Schematic Diagram of Power Suppl



RESISTORS 1/2WATT UNLESS OTHERWISE SPECIFIED

RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K= 1000 OHMS M= 1 MEGOHM

CAPACITANCE VALUES ONE AND OVER IN MICRO MICROFARADS LESS THAN ONE IN MICROFARADS UNLESS OTHERWISE SPECIFIED

○ KNOB CONTROL

⊘ SCREWDRIVER ADJUST

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